POWER PLANT ENGINEERING

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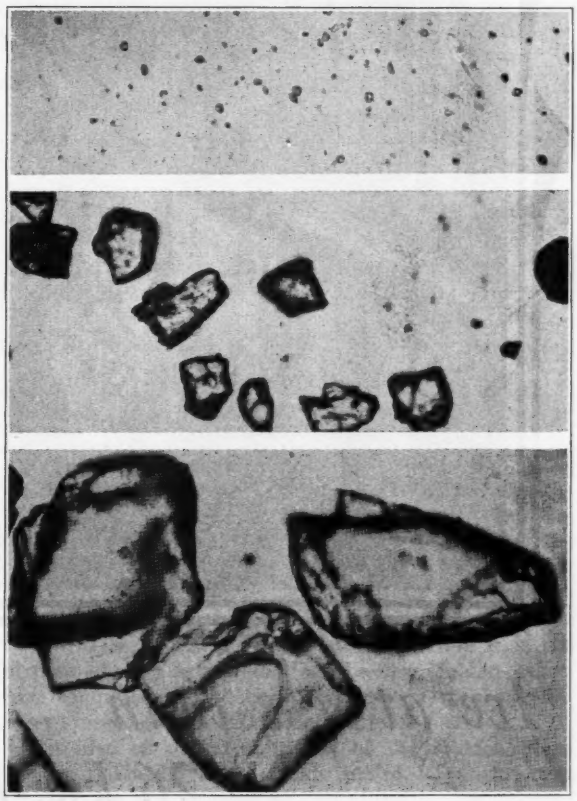
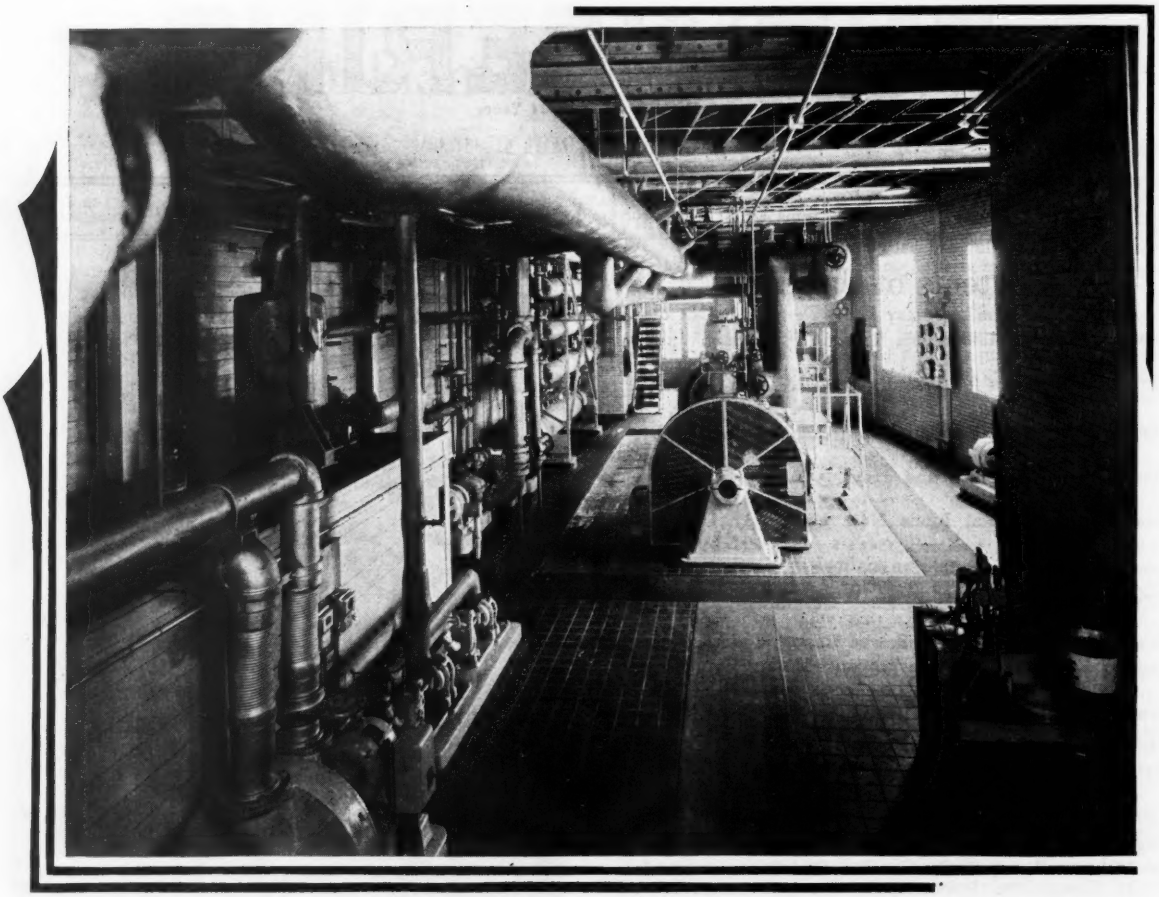


Should an Engine Have Grit?

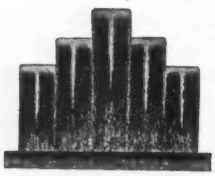
DIESEL MEN have become air minded. They are deeply concerned with what is in the air. They recognize the fact that, although plenty of grit is important to personal success, dust and Diesel do not mix without friction. In the case of a Diesel engine, dust often scores a mark but it is always a bad one. Their interest in these marks led Diesel operators to view the subject through a high-powered microscope and what they saw is shown in the above picture, which depicts three grades of marble dust, the largest in size, 0.062 mm. may be carried without difficulty by the current of air served to a Diesel Engine.

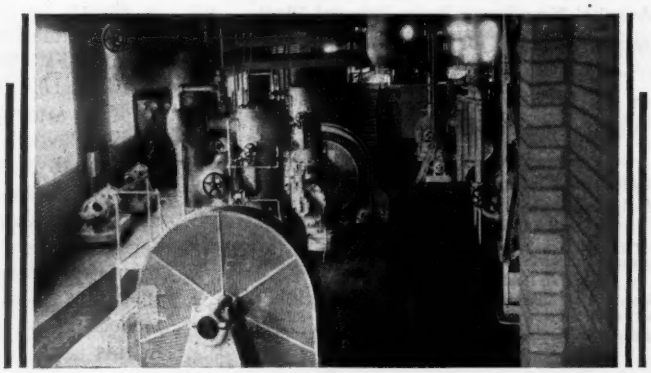
First attempts at air filtration were by the use of a pebble-filled pit. The first unit-type air filter was filled with small pipe nipples. Air filters are no longer in the pipe-nipple stage. Now the air which passes through them is so changed in spirit that it is divested of all earthy substances and made fit for service in any well regulated Diesel. Developments have been so rapid that air filters have become standard equipment in modern Diesel plants such as that described elsewhere in this issue.

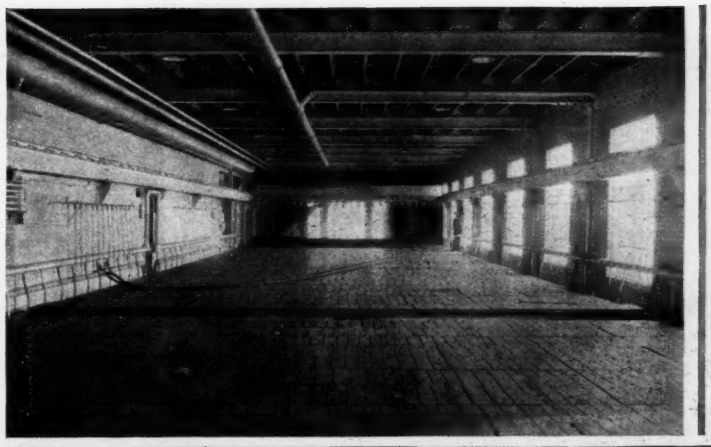


Ice at less than 26 kw-hr. per ton

WITH a power consumption of 25.8 kw-hr. per ton for the month of January. This new plant of the Boston Ice Co. establishes a new record for Winter production. This low consumption is attributed to the fine balance in the plant and the unusually low auxilliary load. When this record was made the plant was operated with one machine pulling an average of 90 t. per day.







New Ice Plant at Malden sets record For Efficient Winter Production

AMONG THE MANY FINE ice plants which the Boston Ice Co. has erected in Boston and vicinity during the past few years, one of the most recent to be placed in operation is the new plant at Malden. About a year ago[1] there appeared in this publication a description of another plant of the Boston Ice Co., the Cambridge plant. This plant, it may be recalled, was characterized by many excellent engineering features, typical however, of all of this company's installations. It is natural, therefore, that the Malden plant, being the latest, should not only have features similar to those of the other plants but, in addition, certain improvements which experience in other plants proved desirable.

A visit to any one of these ice plants will show the great advance in the design of refrigerating equipment over that of the old steam driven distilled water plant with its cumbersome tanks and damp, clammy atmosphere. Refrigeration, like so many other of the modern conveniences, is accepted by the average person largely as a matter of course and while he notes improvements in those things with which he comes in direct contact, the ice which comes to his home, while it may be clearer, looks much like any other ice and he little realizes that during the time that electric phonographs, radio and domestic mechanical refrigeration have come into being, the ice plant which makes the ice he buys has also undergone revolutionary development. These new electrically operated ice plants of the Boston Ice Co. are as unlike the old time ice plant as the modern orthophonic victrola is different from the squeaky phonographs of the nineteen hundreds.

The Cambridge plant, referred to, together with the Dorchester plant, was placed in operation about the middle of 1928. The new Malden plant first went into production on May 27 of last year, that is, 1929, about a year after the Dorchester and Cambridge plants.

In the Dorchester plant, the design was hampered by lack of ground area and it is somewhat crowded as compared to the other plants, although this crowding detracts in no way from its performance and even its appearance.

At the new Malden plant, more space was available than at Dorchester; as a consequence the plant is quite roomy, a feature which is further emphasized by the fact that vertical compressors are used. This plant also incorporates an ice storage house of some 4500-t. capacity, which, while lacking at Dorchester at the present time, will be provided in the future. While it is the purpose of this article to describe the Malden plant, these comparisons with the Dorchester plant are of interest since both are 120-t. installations.

An idea of the arrangement of the Malden plant may be obtained from the plan in Fig. 2, which shows not only the arrangement of equipment in the machine room but also the tank room, delivery room and the storehouse. The machine room is approximately 95 ft. long and in width varies from 24 ft. at one end to about 35 ft. at the other. At one end is the engineer's office, storeroom and boiler room (for heating the building) and at the other is the transformer and switch room.

All of the Boston Ice Co. plants are electrically driven, current usually being delivered at high voltage and stepped down to 440 or 2300 v. for the motors. The Malden plant is unusual in this respect, however, for the current, delivered to the plant at 4000 v., is used directly at that voltage by the main synchronous motors. This feature eliminated the necessity of providing transformers with a consequent reduction in investment charges. For the smaller motors throughout the plant, 220 v. is used and transformers are provided to supply this voltage.

Plant Built for 120 T. Capacity

This plant as already stated, was built for a capacity of 120 tons daily but, during the warm months, the production was considerably greater than this. During July and August of last year, the average daily tonnage

[1] April 15, 1929, page 452.

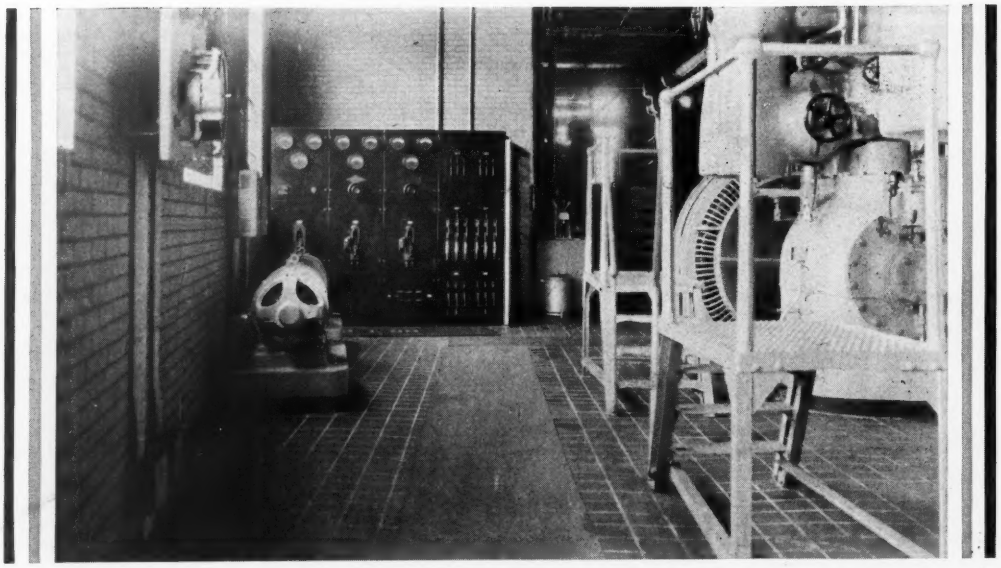


FIG. 1. ANOTHER VIEW IN THE COMPRESSOR ROOM SHOWING THE ELECTRICAL SWITCHBOARD

was 134 and this was produced at an expenditure of 45.3 kw-hr. per ton.

To produce this ice, two ammonia compressors are provided. These are the latest York, type Y-2, two-cylinder vertical units. These machines are equipped with valves whereby the cylinder volume can be reduced or increased as desired. They are 12½ by 14½-in. machines running at 200 r.p.m. The displacement per revolution of each machine is 3559.3 cu. in., which, when running at normal speed, gives a displacement of 711,800 cu. in. per min. The total displacement for two machines is 1,423,600 cu. in. per min. and 10,624 cu. in. per ton of ice.

As is more or less standard with the Boston Ice Co., these machines are driven by Electric Machinery Co., synchronous motors. These units, which are direct connected to the compressors, are rated at 175 hp., 4000 v., 200 r.p.m., 3 phase, 60 cycles. They require 32 amp. at 125 v. for excitation when operating at a power factor of 100 per cent.

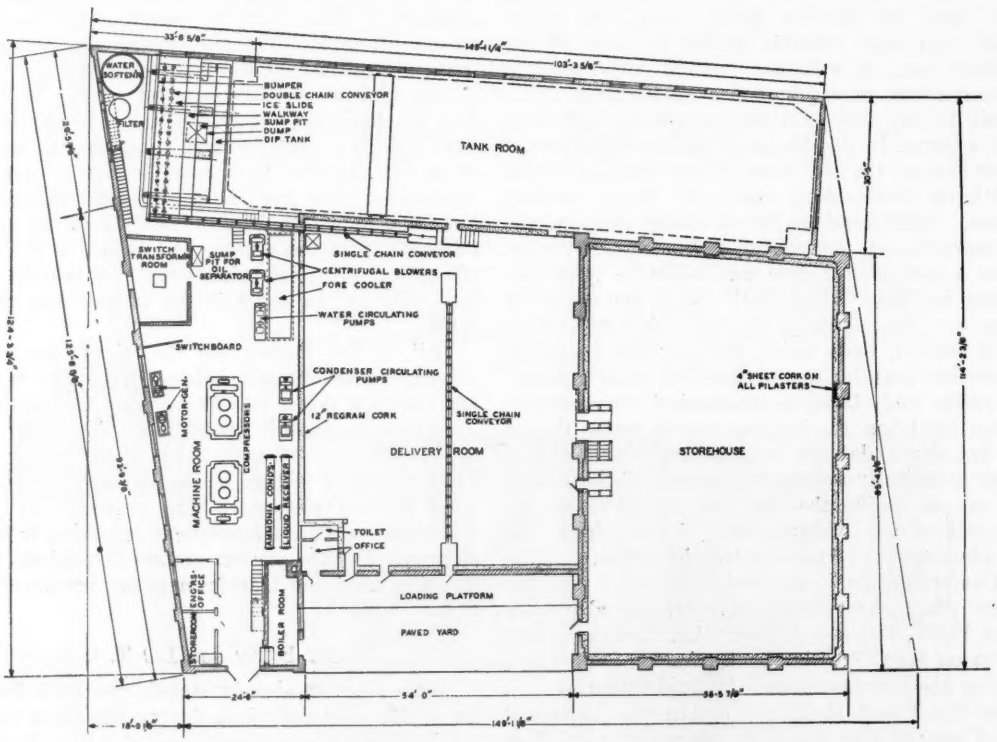


FIG. 2. PLAN OF THE MALDEN ICE PLANT SHOWING RELATIVE LOCATION OF VARIOUS ROOMS AND EQUIPMENT

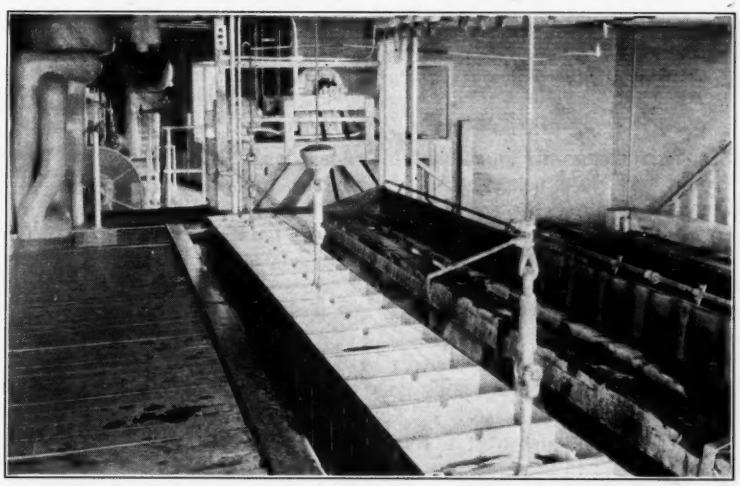


Fig. 3. Dipping a full row of 26 cans, preparatory to dumping. After being dipped the 26 can grid is placed on the dumping table at the right, which then turns the cans on their sides

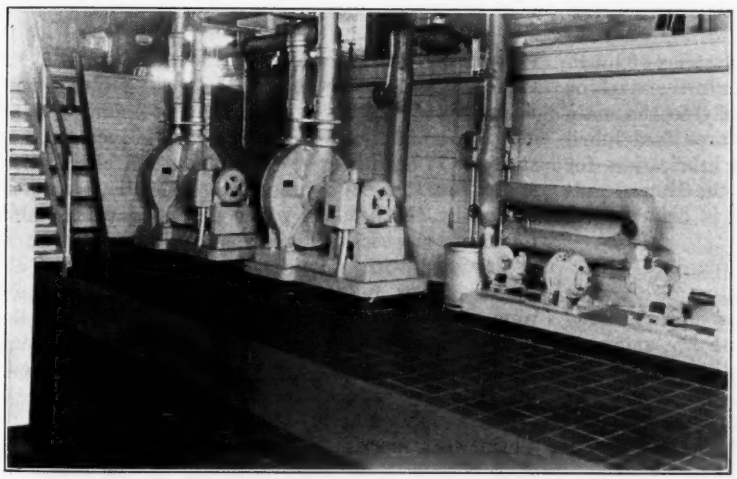


Fig. 4. Two centrifugal blowers, deliver air at about two pounds pressure to the aerating system. In this photograph, these are shown at the left. The small pumps at the right deliver pre-cooled water into the surge tank

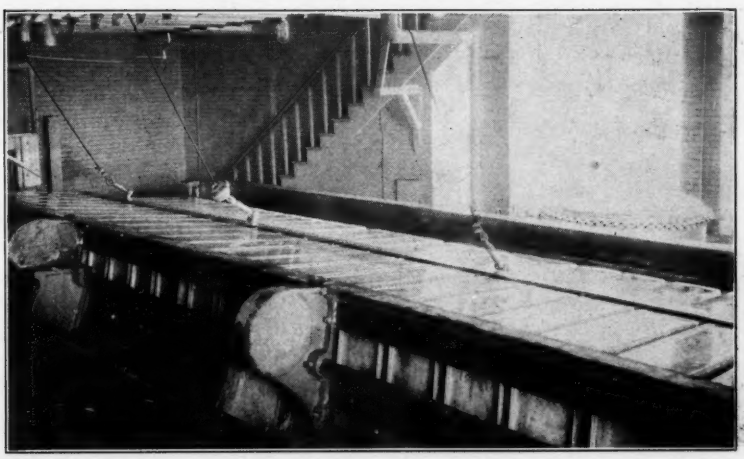


Fig. 5. A 26-can grid being dumped. The dumping table shown in an upright position in Fig. 3 has now turned so that the ice cakes slide out onto the conveyor

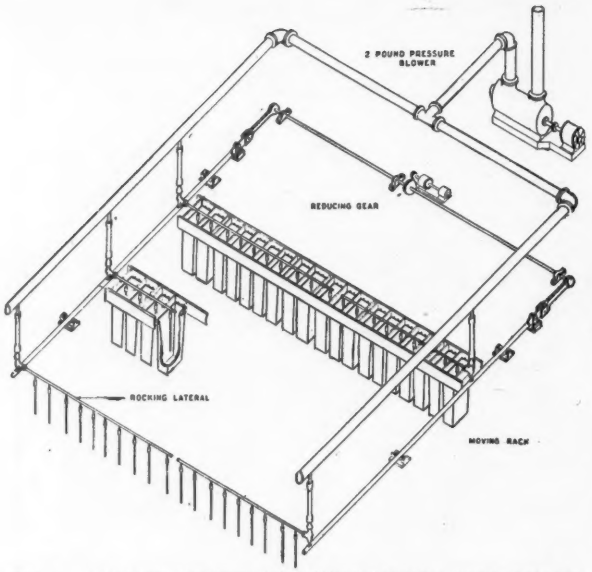


FIG. 6. LAYOUT OF THE KNICKERBOCKER MECHANICAL PENDULUM AERATING SYSTEM

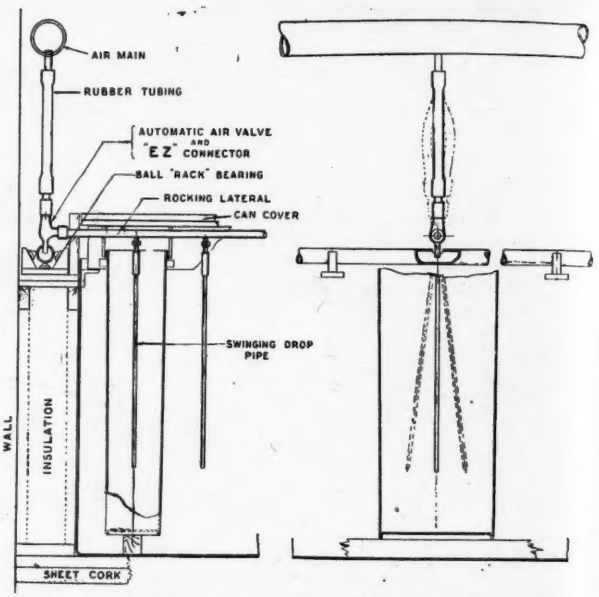


FIG. 7. SECTIONAL VIEW OF THE AERATING SYSTEM SHOWING AUTOMATIC AIR VALVE AND OPERATION OF MECHANICAL DROP PIPES IN CAN

Exciting current is provided by separate motor-driven exciter units.

The compressors are fitted with two systems of lubrication, one utilizing a gear pump built into the machine by the manufacturers and geared directly to the main shaft, and the other is a Manzel 4-pt. force feed lubricator. The gear pump unit furnishes lubrication for the main bearings and wrist pins while the Manzel unit is for cylinder lubrication. The latter is driven from the main shaft by belt.

A shell type multipass condenser is used. This installation consists of eight 16-in. shells, on two stands each having 42 1¼-in. galvanized tubes and arranged to provide 5 passes. The condenser with the ammonia liquid receiver below may be seen in the photograph, on page 316.

The condenser circulating water pumps are De Laval centrifugal units, one having a capacity of 500 g.p.m. and the other 1000.

Condenser water is cooled by means of a cooling tower mounted on the roof. The amount of water in the bottom of the cooling tower is regulated by a Schade valve. Should the water in the cooling tower pan fall below a safe level, the Schade valve operates to admit city water to the system until the proper level is restored. It comprises a diaphragm controlled valve installed on the city water line. The diaphragm is actuated by the head of water coming down a half-inch line from the cooling tower pan. The diaphragm space is provided with an outlet so that if the level at the cooling tower falls, no water will enter the half-inch pipe and the water in it will flow out of the outlet in the diaphragm chamber. This causes the pressure to be relieved and as a consequence the diaphragm will open the city water valve.

FIG. 8. DELIVERY ROOM, SHOWING THE ICE SCORING MACHINE AND ONE OF THE CONVEYORS

The freezing tank is 118 ft. 10 in. long by 27 ft. 10 in. wide and is 54 in. deep. It is made of ¼-in. steel with a ¼-in. steel bulkhead in the center. The bottom of the tank is insulated with 4-in. concrete slab, 4-in. hollow tile, and 5 in. of sheet cork next to the tank bottom. The dip tank end of the freezing tank is also insulated with 5 in. of sheet cork. Both sides of the tank are insulated with 10-in. regranulated cork.

As in the Cambridge plant, the can grids are those of the Knickerbocker Stamping Co. In this system, known as the Knickerbocker multiple can grid system, each can is suspended by a band resting on a square bar running the full length of the wide side of the can. Each can is held firmly in place by four countersunk head rivets and any individual can can be slipped in or out of the grid without interfering with any other can.

Each can grid is 26 cans wide and a full row of cans is harvested at one time. For pulling and filling, a 7½-t. Euclid crane is provided. With fifty-three 26-can grids, a total of 1378 cans are available, giving 10.3 cans per ton of ice. These are all standard 300-lb. cans, 1128 of which are riveted and 253 welded.

Multiple Can Filling

Cans are filled by means of the York multiple can filling system. This comprises a tank with as many com-

partments as there are cans, in this case, 26, each compartment having an outlet with a curved nozzle for delivering the water into the cans. Each compartment is designed to hold just enough water to fill one 300-lb. ice can. The amount of water delivered to the can filling tank is controlled by a float so that there is no danger of overflow. When a grid of 26 cans is to be filled it is placed so that each can is underneath one of the nozzles of the filling tank. By means of a lever, all compartments are discharged at once, the actual operation of filling the cans in a grid taking only a few seconds.

For those unfamiliar with the Knickerbocker Mechanical Pendulum, low-pressure aerating system used at this plant as in all plants of the company, a brief description may be of interest. This system operates on an air pressure of less than 2 lb. in combination with a system of swinging drop pipes, one for each can. A typical layout is shown in Fig. 6 while in Fig. 7 are shown the details of the mechanism. The swinging drop pipes, which suspend into the ice cans directly from the rocking laterals are connected to the air main through short lengths of rubber hose. A one-horsepower motor requiring 0.86 kw. per hr. through the agency of a speed reducer and a moving rack, slowly oscillates all the drop pipes during the freezing process. This allows of the pulling of an unusually small core as a rule less than one gallon and produces clear and brilliant ice. Air is supplied to the system by two two-stage centrifugal compressors. One of the compressors is used at a time supplying 700 cu. ft. of air requiring 8.8 kw. per hr.

Cores are sucked by means of two Viking core pumps, driven by 3-hp. motors.

The two brine coolers are of the horizontal shell and tube submerged type, having 281—2-in. O.D. No. 9 gage steel boiler tubes. The tube sheet is 7/8 in. thick and was tested to 200 lb. air pressure under water. These coolers are fitted with automatic float liquid level controls.

Effective circulation of the brine around the cans is maintained by two 24-in. Halverson agitators driven at 182 r.p.m. by 3-hp. motors. Power required for the two agitators, 5.6 kw. per hr.

It might be of interest to note that on this system it requires 20.4 hp. or 15.26 kw. per hr. for agitating brine and complete aerating system, including blower.

Water System

Raw water obtained from the city mains is treated by an International chemical feeder and mixed with alum and KWS. The water-treating system which is located at one end and in the upper part of the freezing room consists of four tanks, two containing alum solution, one the KWS solution and the fourth serving as a surge tank for the treated water. Raw water passes through a chemical mixer where the chemicals are added in proportion to the amount of water flowing through the mixer, and then passes into the settling tank. From the settling tank, the treated water flows by gravity through a filter and a forecooler, located in the machine room and then by means of two small centrifugal pumps is delivered to the surge tank, from which in turn it flows by gravity into the multiple can filling tank. The two pumps delivering the water to the surge tank are controlled automatically by a Mercoid Float switch in the surge tank.

This system is somewhat different from that employed at Dorchester, where the forecooler is combined with the settling tank and where the filter is located just ahead of the surge tank. Experience with this system seemed to indicate that it is advisable to separate the forecooler from the settling tank and for this reason the arrangement at Malden was decided upon.

The water forecooler used at Malden is a York high-pressure cooler with vertical trunk evaporating coils and is also used for precooling all ammonia liquid used in the brine coolers. It has a vertical agitator and an automatic float on the liquid level. The suction from the forecooler evaporating coils is connected into one of the cylinders of the compressors and operates under about 50 lb. back pressure.

Particular care was taken in the covering of the

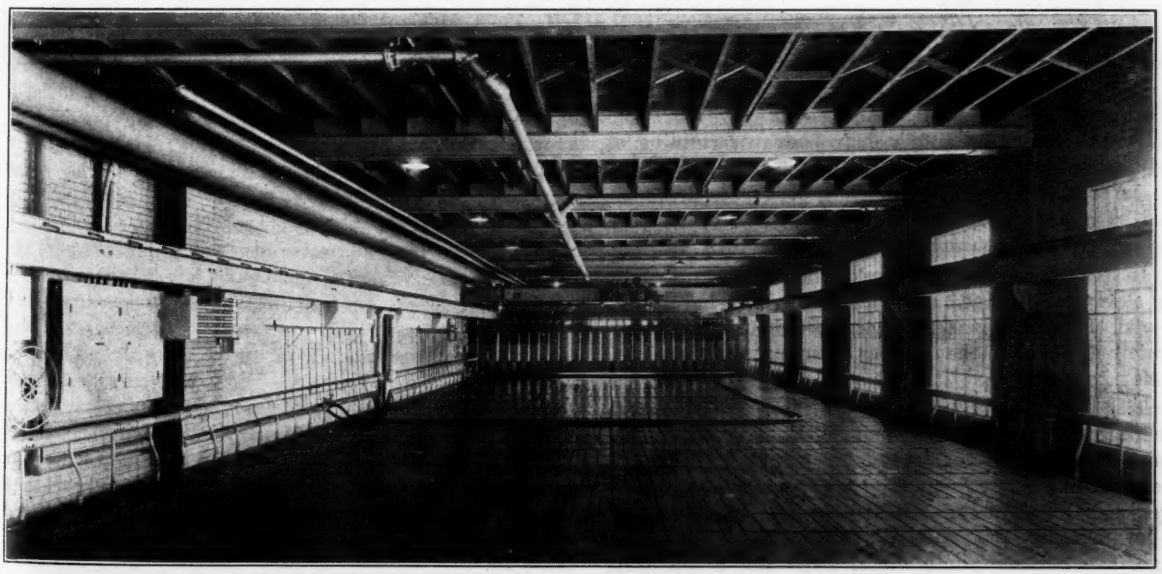


FIG. 9. TANK ROOM AT THE MALDEN PLANT SHOWING ONE ROW OF WELDED CANS IN GRID

ammonia lines. These were first wrapped with two layers of friction tape. Over this was then applied, first, two layers of 1½-in. felt and then one layer of 1-in. felt with a layer of insulating paper between each layer of felt. Next, two layers of friction tape were applied over the felt and this was painted with two coats of asphalt paint. A layer of rosin paper and an outer covering of 8-oz. canvas completed the covering. The two layers of friction tape between the felt and the rosin paper are of particular importance as they provide an absolute air seal around the whole covering.

In harvesting the ice, an entire row of 26 cans is pulled and after being dipped, is dumped directly onto a Gifford Wood transverse double chain conveyor which delivers directly to a single chain conveyor running at right angles to the first conveyor, which in turn delivers the ice to the delivery room. Both conveyors are operated by a single 7½-hp. motor, so installed as to drive the conveyors synchronously.

In the storage, ice is handled by single automatic gig elevators, equipped with pneumatic lowering attachments. Storage capacity in the storehouse is approximately 4500 t. In the delivery room, an additional 500 t. may be stored.

The plant is well provided with gages and instruments in order that a continuous check may be kept on operation. A gage panel in the machine room contains the more important gages for the operation of the compressors. These include a high-pressure ammonia gage, 2 low-pressure gages, high-pressure ammonia alarm gage, a condenser pump alarm gage and a recording meter for high and low-pressure ammonia back pressure. The compressors are equipped with a General Electric cutout switch which trips the motor circuit if the pressure on the discharge side exceeds a safe value. Before the automatic trip acts, however, an alarm rings so that an attendant can correct the cause of the trouble before the machine actually shuts down.

Control of electrical equipment is by means of a four-panel switchboard.

Conclusions

As previously stated, this plant was put in operation May 27, 1929, and the average power consumption per ton of ice made has been as follows, which includes all of the power required by the ice handling machinery, as well as lights:

June	44.4	kw-hr.	per	ton
July	46.3	"	"	"
August	43.9	"	"	"
September	44.4	"	"	"
October	33.0	"	"	"
November	34.1	"	"	"
December	32.2	"	"	"
January	25.8	"	"	"

During the month of January, the plant was operated with one machine pulling on an average of 90 tons of ice per day. While it is a fact that the cold weather helps to reduce the power cost, the auxiliary load must be unusually low in order to get the average down below 26.

In any ice plant a lower temperature condensing

Principal Equipment Installed in the Malden Plant of the Boston Ice Co.

GENERAL

Location of plant.....Malden, Mass.
Owners .....Boston Ice Co.
Capacity.....120 t. daily
Number of cans.....1378
Size of cakes..11 by 22 by 42 in.—300 lb.
Compressor displacement per ton.....11,863 cu. in.
Ice storage capacity.....4500 t.

EQUIPMENT

2 Vertical, duplex, type Y-28, 12½ by 14½-in., 200-r.p.m., ammonia compressors. Displacement per revolution, 3559 cu. in. Total displacement at 200 r.p.m. 711,800 cu. in. York Ice Machinery Corp.
2 Synchronous motors, 175-hp. 100 per cent power factor, 4000 v., 3 phase, 60 cycles, requiring 32 amp. at 125 v. for excitation at 100 per cent p.f. Electric Machinery Co.
2 Exciter sets, each consisting of 1—12.5-kw., 125-v. d.c. generator driven by a 20-hp., 220-v., 3-phase, 60-cycle induction motor. Electric Machinery Co.
1 Shell type, multipass ammonia condensers consisting of 8—16-in. shells each with 42—1¼-in. tubes. York Ice Machinery Corp.
1 Ammonia receiver. York Ice Machinery Corp.
1 1000-g.p.m., 65-ft. head, 1750-r.p.m. condenser circulating pump, De Laval Steam Turbine Co., driven by 25-hp., 220-v., 3-phase, 60-cycle, Linc-Weld motor.
1 500-g.p.m., 65-ft. head, 1750-r.p.m. condenser circulating pump, De Laval Steam Turbine Co., driven by 15-hp., 220-v., 3-phase, 60-cycle, Linc-Weld motor.
Oil filters and tanks.....S. F. Bowser & Co., Inc.
2 Tabco centrifugal blowers, 2-stage, pressure 2-lb., Allen and Billmyre Co., driven by
2 10-hp., 220-v., 60-cycle, 3-phase, induction motors. Star Electric Co. with Cutler-Hammer a.c. automatic starters.
2 Brine coolers, horizontal, shell and tube submerged type, each 49½ in. by 20 ft. with 281—2-in. O.D. steel boiler tubes No. 9 B.W.G. 20 ft., ½ in. long. Shell ⅜ in. thick. Tube sheet ⅞ in. thick. Tested to 200 lb. air pressure under water. York Ice Machinery Corp.
2 Brine agitators, 183-r.p.m. Halvorsen (M. & S.) driven by.
2 General Electric Co., 3-hp., 220-v. induction motors.
1 International water filter, pressure type, 60 in. diameter. International Filter Co.
2 Water circulating pumps, 65 g.p.m., 30 ft. head, 1735 r.p.m. Scranton Pump Co., driven by.
2 General Electric Co., 1½-hp., 220-v. induction motors.
1 Fore cooler, 20 ft. 6 in. by 4 ft. 6 in. by 5 ft. 8 in. deep, with vertical trunk evaporating coils, with vertical agitator and automatic liquid control. Tank and coils galvanized. York Ice Machinery Corp.
4 Chemical treating tubs, all built of 1¼ in. cypress.
2 Alum tubs 36 in. by 36 in.
1 K.W.S. tub 36 in. by 36 in.
1 Raw water tub or surge tank, 36 in. by 36 in.
1 Settling tank, 8 ft. 6 in. by 19 ft. high—made of 3-in. Red Gulf cypress wood equipped with International chemical feeding apparatus.
2 Sump pumps, Dayton-Dowd, 35 g.p.m., head 50 ft., r.p.m. 1750, driven by.
2 G.E. motors, hp. 1½, 220 v.
1 Freezing tank, 118 ft., 10 in. long, 27 ft., 10 in. wide, 54 in. deep, made of ¼-in. steel with ¼-in. steel bulkhead in center. 1378 cans in 53-26 can grids. Knickerbocker Multiple can grids and cans. Knickerbocker Stamping Co.
Tank covers, Victor Cooler Door Co. Aerating system, Knickerbocker Mechanical Pendulum system, Knickerbocker Stamping Co.
1 Cooling tower. Cooling Tower Co.
2 Viking core pumps driven by 3-hp. General Electric Co. induction motors.
1 Can filling tank, 26 compartments with automatic float control. York Ice Machinery Corp.
1 Schade regulating valve for cooling tower water level control.

CONVEYORS AND ICE HANDLING MACHINERY

2 Tank room conveyors, 1 double chain, 1 single chain, driven by 7½-hp. General Electric motor through Philadelphia reduction gear. Gifford Wood Co.
1 Single chain conveyor and ice stacker in delivery room. Gifford Wood Co.
2 Single automatic elevators equipped with pneumatic lowering attachments in store house. Gifford Wood Co.
1 Euclid crane, 7½-t. Euclid Crane and Hoist Co.
1 Perfection ice scoring machine.
4 37½-kv-a. General Electric transformers (1 spare) 2300/4000 to 115-230 volt.

MISCELLANEOUS

Gages for indicating pressures..Consolidated Ashcroft Hancock Co., Inc.
Hair felt covering throughout.....Keasbey and Mattison Co.
Electrical work installed by.....H. M. Haley Elec. Co., Boston, Mass.
Building erected by.....Vappi and Ferguson, Inc., Cambridge, Mass.

water will effect some reduction in power due to the lower head pressures which decreases the amount of power required to drive the compressors. But the auxiliary load of course increases as when the plant is operating on reduced capacity, practically all of the auxiliaries are working and using as much power as when the plant was running full. In a good many plants, therefore, the advantages gained from the more favorable weather conditions in winter are quite often offset by the increase in auxiliary load. In the Malden plant, the balance is such as to make it possible to get this excellent winter record.

Of the eighty plants that the American Ice Company supervises, this is the lowest kilowatt-hour consumption per ton for January, and it has established a new record.

While pulling 90 tons, one man on a shift is employed, or a total of three men on the manufacturing crews, so that the plant has in every way come up to the fullest expectations of the designers as to economy and use of power and labor.

In appearance, the plant leaves little to be desired. With floors of red tile, walls of special buff brick and with other machinery painted a light cream color, the interior presents a spotless atmosphere.

The plant was designed by the engineering department of the American Ice Co.

In concluding this description, we wish to acknowledge our indebtedness to Rudolph Sommers of the Boston Ice Co. for courtesies extended and supplying information on which this article is based.

Extraction Turbines for Laundry Service

ANALYSIS OF CONDITIONS SHOWS THAT EXTRACTION UNIT FITS NICELY INTO THE LAUNDRY PLANT HEAT BALANCE. BY J. Y. DAHLSTRAND*

PROGRESSIVE LAUNDRY ENGINEERS realize that, when considered from a standpoint of overall economy, the correct way to take care of their power requirements is to generate this power by means of steam prime movers. Inasmuch as the laundry requires steam for its various processes the power becomes a by-product and a well-managed plant will save its entire power bill except for an amount corresponding approximately to from 10 to 15 per cent of the annual coal cost.

This small percentage covers several items: increase in coal burned because of heat abstracted for power; supplies and lubrication; interest on investment; depreciation of the power unit, and increased insurance. It does not cover additional maintenance because, in general, the power unit in the average small laundry can be cared for by the boiler room attendant.

Until recently steam prime movers used in laundries were steam engines of the corliss or uniflow type. The turbines did not receive consideration because of the somewhat higher steam consumption of a noncondensing turbine of the size ordinarily used for this service.

TURBINE OFFERS ADVANTAGES

The advent of the small extraction turbine developed especially for laundry service has, however, eliminated this objection. By means of it a steam performance may be obtained which in many cases will be superior to that obtainable by other methods. This unit also permits the laundry engineer to avail himself of many other advantages not otherwise obtainable.

Uses for steam as a heating medium in a laundry fall into two classes requiring the steam at different temperatures and pressures. The first class generally demands saturated steam at a temperature of 320 deg. corresponding to a gage pressure of 75 lb. This pressure varies for different laundries but it generally ranges from 70 to 90 lb. This may be called intermediate pressure and is used in a laundry for the flat work ironers, presses, tumblers and dry rooms.

The second class can generally utilize steam at a pressure slightly higher than atmospheric pressure,

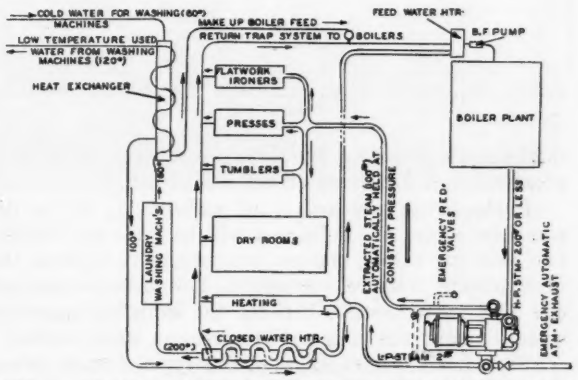


FIG. 1. DIAGRAMMATIC REPRESENTATION OF A TYPICAL LAUNDRY SHOWING THE TEMPERATURES AND PRESSURES PREVAILING

often about 2 lb. gage pressure. This may be called low pressure and is generally used in a laundry for heating the water used in the washing machine, heating the buildings and heating the feedwater to the boilers.

To assume an arbitrary case, one may take a laundry generating steam at 200 lb. ga. pressure with no superheat and using steam for the first class at 70 lb. ga. pressure and for the second class at 2 lb. ga. pressure.

If an engine were used here as a prime mover, the exhaust steam from this engine would be utilized for the second class requirements but it would be necessary to take high-pressure steam direct from the boilers and throttle it through a reducing valve to the intermediate pressure for the use with the first class requirements listed above.

LOAD SHIFTED AUTOMATICALLY

Extraction turbines will take high-pressure steam from the boiler and will extract automatically from an intermediate stage such an amount of steam at 70 lb. pressure as may be required and exhaust the balance at 2 lb. pressure for use in the apparatus enumerated under class two. This turbine will automatically shift the load from the low-pressure to the high-pressure end of the turbine when there is a great demand for steam at the

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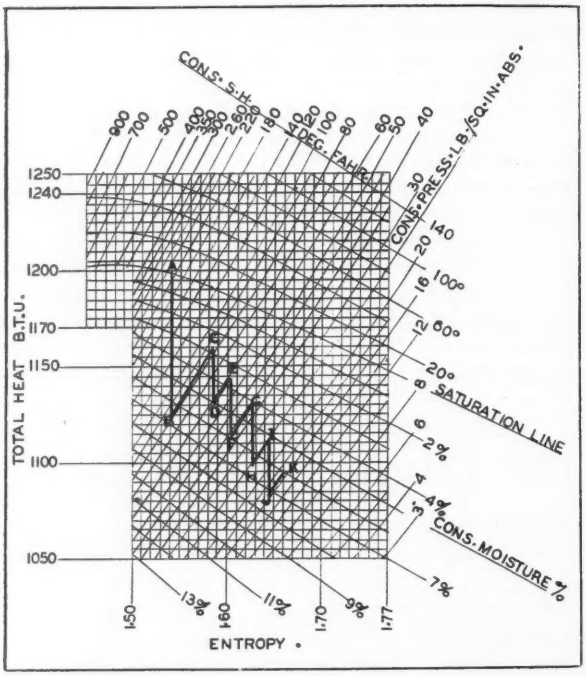


FIG. 2. HEAT PERFORMANCE OF A TYPICAL FIVE-STAGE TURBINE

intermediate pressure and vice versa when there is a great demand for steam at the low pressure.

If the power required is not sufficient to fit the demand for steam, the deficiency will be made up through two reducing valves, one low-pressure valve between the intermediate pressure line and the low pressure line and one high-pressure valve between the main high-pressure steam line and the intermediate pressure steam main.

Fundamental advantages of this type of steam prime mover will be apparent. A considerable percentage of the power is extracted between the high and intermediate pressures which is not available for power with any other arrangement. To illustrate this further, the diagram in Fig. 2 can be used to show the performance of an extraction turbine plotted on the usual type of Mollier or heat-entropy diagram.

At 200 lb. ga. pressure and saturated steam, the total heat content per pound of steam is 1199 B.t.u. If this steam is expanded adiabatically in turbine nozzles, the heat content in the steam when leaving the nozzles

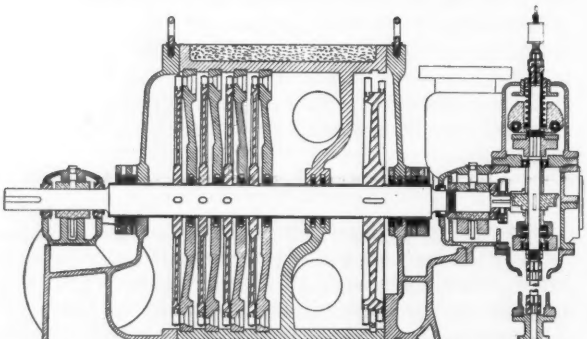


FIG. 3. CROSS SECTION OF A FIVE-STAGE TURBINE ARRANGED FOR EXTRACTION BETWEEN THE FIRST AND SECOND STAGES

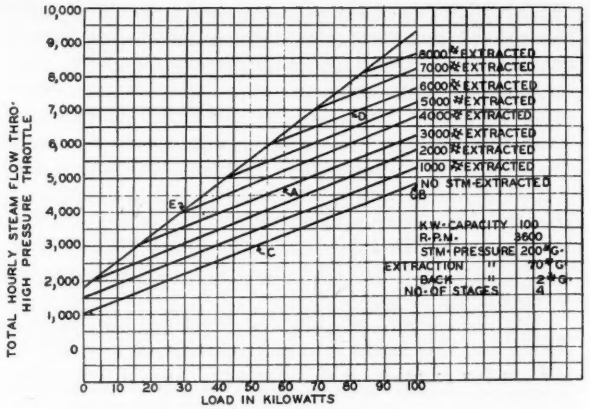


FIG. 4. STEAM CONSUMPTION OF A 100-KW. UNIT UNDER ALL CONDITIONS OF OPERATION

at 70 lb. ga. pressure would be 1126 B.t.u. per lb. of steam and the heat available for power absorption in the high-pressure end of the turbine (or that ahead of the extraction point) would be 73 B.t.u. per lb. of steam. With a turbine capable of absorbing 55 per cent of the steam in form of power, the remaining heat would of necessity have to reheat the steam so that when leaving the wheel of the high-pressure stage of the turbine the total heat content of the steam per pound would be 1159 B.t.u. and the moisture content would be 2.9 per cent. If the low-pressure end of the turbine had four stages as shown in Fig. 3, the heat performance throughout the balance of the turbine would be as shown in Fig. 2 by the zigzag line and the final heat content in the steam leaving the turbine would be 1095 B.t.u. per lb. with a moisture content of 6 per cent.

A typical chart showing the steam consumption performance of a 100-kw. extraction power unit under all conditions is given in Fig. 4.

Examples Solved by Use of Chart

Assume that 3000 lb. of steam are required at the intermediate pressure with a load on the unit of 60 kw. The power developed corresponding to this steam flow would be 21 kw. or 35 per cent of the total amount of power developed by the unit. The total steam required for every condition of power demand may be found on chart and from this the steam rate per unit of power. To serve as an illustration several points

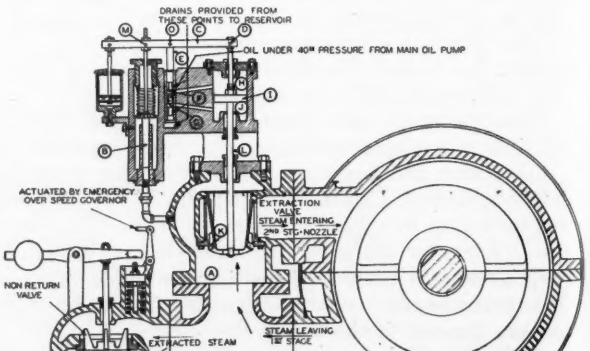

DRAINS PROVIDED FROM THESE POINTS TO RESERVOIR
OIL UNDER 40# PRESSURE FROM MAIN OIL PUMP
ACTUATED BY EMERGENCY OVER SPEED GOVERNOR
EXTRACTION VALVE STEAM ENTERING 2ND STG. NOZZLE
NON RETURN VALVE
EXTRACTED STEAM
STEAM LEAVING 1ST STAGE

FIG. 5. ARRANGEMENT OF EXTRACTION VALVES

have been taken for varying loads and extractions and are given in the table. All the figures were determined from the chart.

The turbine extraction governing device is clearly illustrated in Fig. 5. The valve proper consists of a double seat poppet valve interposed between the first and succeeding stages of the turbine. All the steam which is not extracted must pass over the seats of this valve and the function of the extraction governing apparatus is to maintain the pressure in the bleeder main constant.

In order to avoid differences in this pressure for changes in load and for changes in amount of extraction, a relay type of governor is used. The steam from

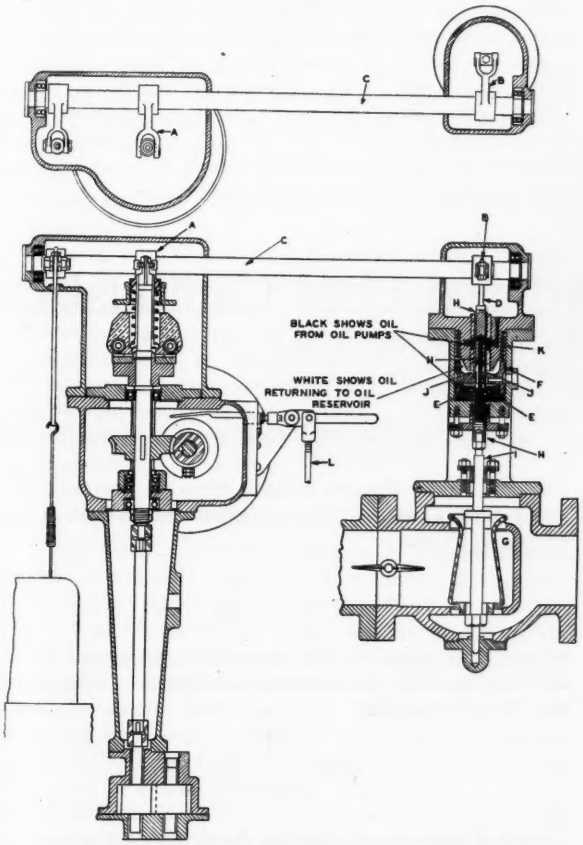


FIG. 6. DETAILS OF THE OIL PRESSURE SPEED GOVERNOR

the extraction main operates on the pressure diaphragm which, in its turn, actuates a pilot valve admitting and discharging oil from one or the other sides of the actuating piston which controls the main extraction valve. The operation of this mechanism will be apparent from the illustration. In the extraction line is provided a nonreturn valve so arranged that it will close automatically for a reversal of the steam flow in the line. It will also be forcibly closed by the emergency governor on the turbine in case of overspeeding.

For speed regulation, the turbine is equipped with an oil relay governor, the construction of which is illustrated in Fig. 6. The nozzles and blading of the turbine are made of monel metal or stainless steel so as to resist corrosive and erosive action. The shafts are of such proportions that the turbines rotors will not have any critical speeds within the operating range.

Typical Cycle Explained

It is the function of the extraction regulator to maintain a constant pressure in the extraction piping.

To gain a knowledge of the method of operation, one might assume that there is a tendency for this extraction pressure to increase as might result from a sudden increase in load on the generator unit or a sudden decrease in steam demand from flatwork ironers or tumblers.

Such a tendency to an increase in pressure would immediately move plunger B, Fig. 5, and point M and O on floating lever C up with pin D as fulcrum. This pulls pilot valve E up and opens ports F and G.

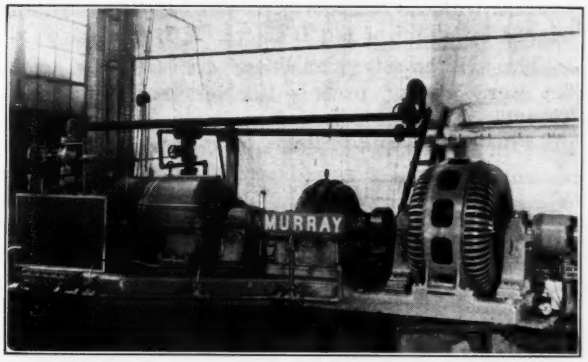


FIG. 7. A 300-KW. GEARED EXTRACTION UNIT BEING TESTED

Opening of port F allows oil from oil pump to enter the upper port of piston chamber H, forcing piston I down.

When port is open, the oil is released from the under side of the piston chamber J and returned to the oil reservoir through drains.

When piston I moves down, valve K will open, allowing excess steam to enter second-stage nozzles.

When piston I moves down, point D and O on the floating lever C move down with pin M as a fulcrum. This moves pilot valve E down, closing ports F and G.

An exact reversal of these motions will take place in case of a lower extraction pressure.

Operation of the governor, Fig. 6, may be illustrated by assuming a sudden load applied to the turbine. The governor weights close. This pulls the governor rocker arm A down and raises the pilot valve rocker arm B. These levers are keyed to the governor layshaft C. Rocker arm B will pull up pilot valve D and open ports. (This is the position shown in Fig. 6.)

Oil will now be admitted to the lower side of the piston F. This will raise the piston F and steam chest valve G, which are fastened together by the pilot valve bushing H and valve stem I.

Just as soon as ports E open, ports J will open, relieving the oil from the upper side of piston F. The piston F at all times will follow the pilot valve D and the relative position of pilot valve and piston, in the drawing, is one which will never exist except momentarily just as the movement of the valve takes place.

When the governor and valve are in stabilized condition, then the ports E and J will be fully closed. When

STEAM CONDITION FOR SEVERAL DIFFERENT ELECTRICAL LOADS FROM FIG. 4

Point	Kw.	Total steam extracted lb. per hr.	Total steam required at throttle lb. per hr.	L.P. steam exhausted to L.P. main	W.R. per kw.
A	60	3000	4700	1700	78.4
B	100	No	4900	4900	49
C	50	No	2930	2930	58.5
D	80	6000	6920	920	86.5
E	30	3850	4050	200 lb. min.	135

starting the turbine, the valve G will be closed by the spring and the ports will stand open as indicated in drawing.

As soon as auxiliary oil pump has built up pressure on the relay system the valve G will open wide and the ports will close. The spring K on top of piston is provided to close valve in case of failure of oil pressure.

The S and K trip and throttle valve used in conjunction with the governor is mechanically operated and tripped by means of rod L shown on drawing.

Through the extraction line steam is supplied to the flat work ironers, presses, tumblers and dry rooms. Through the exhaust line of the turbine steam is supplied for heating and to the water heater. Steam is also supplied from this source for heating of the feedwater. There is also provided in the exhaust line an automatic emergency, atmospheric exhaust valve to relieve the system of excessive pressure in case of a momentary excess of exhaust steam.

Condensate from all the above sources is returned to the boilers. The water after going through the washing machines is generally put through a heat exchanger whereby it will heat to a certain extent the incoming clean water for washing. From this source is also taken the makeup boiler feedwater.

An extraction turbine, as will be noted, maintains perfect pressure balance in the laundry within the range of its capacity and does this automatically, regardless of fluctuations, by shifting the load on the various stages of the turbine. This is, of course, not possible with any arrangement having manual control. In such a case, there will be times when a sufficient amount of steam is not fed to the intermediate system and there will be other times when an excess is fed there. The same thing is true of the low-pressure system. Such momentary changes invariably result in losses of steam and interference with laundry operation.

Thermodynamics of Powdered Coal Combustion

INVESTIGATIONS OF THERMAL CONSIDERATIONS SHOWS DUST FIRING TO BE A VELOCITY PROBLEM. BY DR. ING. P. ROSIN*

LIBERATION OF HEAT in a combustion space is an important thermodynamic quantity which represents the intensity of combustion. It is measured by the number of heat units developed per unit of volume and unit of time during complete and perfect combustion, including the heat delivery by preheating.

Mathematically it can be expressed by

$$B = (3600 \times H_u)\ (V_T \times Z) \qquad (1)$$

where B = heat liberation in (or B.t.u. per cu. ft. per hr.) cal. per cubic meter per hr.

H = lower heating value of the fuel in kilograms calories per kilogram (or B.t.u. per lb.)

V_T = Volume in cubic meters of combustion products of one kilogram of fuel at furnace temperature (or cu. ft. per lb. of fuel)

Z = combustion time in seconds of the coarsest dust grains

If V_o equals the gas volume liberated from one kilogram (1 lb.) of fuel under standard conditions (0 deg. C. and 760 mm.).

$$V_T = V_o \frac{T}{273} \qquad (2)$$

where T is equal to the absolute temperature of the combustion space in degrees Centigrade. Equation 1 can then be written

$$B = 982{,}000 \times \frac{H}{V_o} \times \frac{1}{T} \times \frac{1}{Z} \qquad (3)$$

It has been proved that the quotient $H_u \div V_o$, i.e., the ratio of the lower heating value to flue gas volume under standard conditions follows a definite law for all fuels and for that reason the actual value of the fraction

*Mining Academy of Freidberg, Germany. From a paper presented before the International Conference on Bituminous Coals.

TABLE I. BURNING TIME AND RATE OF HEAT LIBERATION

Burning Time in Seconds	Rate of Heat Liberation		Steam Production		Necessary Furnace Volume for				Ratio Heating Surface to Furnace Volume			
					8.8 lb/ft²/hr. 43 kg/m²/h		20.5 100		8.8 lb/ft²/hr. 43 kg/m²/h		20.5 100	
Z	B Kcal/m³/h	Btu/ft³/hr.	kg/m³/h	#/ft³	m³	ft³	m³	ft³	m²/m³	ft²/ft³	m²/m³	ft²/ft³
4	84,500	9,480	109	6.8	396	14,000	922	32,550	2.5	0.8	1.1	0.4
3	112,500	12,720	145	9.0	297	10,500	691	24,400	3.4	1.1	1.4	0.5
2	169,000	18,950	218	13.6	198	6,990	461	16,280	5.1	1.7	2.2	0.7
1	338,000	37,950	435	27.1	99	3,495	230	8,125	10.0	3.3	4.4	1.4
0.6	564,000	63,300	727	45.3	59	2,082	138	4,880	17.0	5.6	7.3	2.4
0.5	676,000	75,800	873	54.4	50	1,765	115	4,060	20.0	6.6	8.7	2.8
0.4	845,000	94,800	1,090	67.9	40	1,412	92	3,250	25.0	8.2	11.0	3.6
0.3	1,125,000	127,200	1,450	90.3	30	1,059	69	2,460	34.0	11.1	14.0	4.6
0.2	1,690,000	189,500	2,180	136.0	20	706	46	1,625	51.0	16.7	22.0	7.2
0.1	3,380,000	379,500	4,350	271.0	10	353	23	812	101.0	33.1	44.0	14.4

$H_u \div V_o$ can be arbitrarily influenced only by the amount of excess air. Increased excess air increases the gas volume but also lowers the temperature of the combustion space unless the combustion air is highly preheated. The product $V_o \times T$ grows with increasing excess air so that high excess air always is equivalent to a reduction of the rate of heat liberation. Neglecting variations caused by varying excess air, the value of the quotient (heating value divided by volume of the product of combustion) can be considered constant for a given investigation and Equation (3) written

$$B = \text{constant} \times \frac{1}{T} \times \frac{1}{Z} \qquad (4)$$

The numerical value of the constant can easily be calculated for any coal and air excess since the quotient $H_u \div V_o$ can be taken from Fig. 1 for all fuels and excess air ratios. With a theoretical quantity of air and limiting temperature this equation can be written

$$B = 338{,}000 \div Z \qquad (5)$$

which shows the heat liberation as a hyperbolic function of time.

Rate of heat liberation is therefore a velocity problem and its characteristic feature is the time in which combustion is completed in the combustion chamber. But the combustion process is not a simple event; it is a collective term of thermo-physical, thermo-chemical and thermo-dynamic events which occur partly in parallel and partly in series, which, in their relative course and in their mutual velocities, are subjected to great variation.

Combustion Period Rarely Exceeds 4 Sec.

Table I will show the influence of the combustion time by a practical example. It contains, for a steam boiler of 1000 square meters surface (10,760 sq. ft.), the rate of heat liberation, the steam generation per unit of combustion space, the amount of necessary combustion volume for a specific evaporation of 43 and 100 kilograms per square meter per hour (8.8 and 20.5 lb. per sq. ft. per hr.), and the ratio of heating surface to combustion volume for these two rates of heat liberation, or both rates of steam generation. In connection here, it should be remarked that the longest combustion time of the coarsest grains of ordinary pulverized fuel combustion systems does not exceed four seconds.

It may also be said that the rate of heat liberation of most combustion spaces of power plants fired with powdered coal corresponds to a maximum burning time of 1.5 to 3.6 seconds. In locomotives, the heat liberation corresponds to a maximum combustion time of 0.4 to 0.3 sec. The German State Railways demand for a powdered coal locomotive a continuous evaporation such that the longest combustion time for theoretical combustion must not exceed 0.17 second.

It will be realized that the rate of heat liberation of stationary power plant boilers is rather low in comparison with these figures. We try, on one hand, to save heating surface and boiler house space by means of high rates of evaporation; on the other hand, there corresponds, as the table shows, a combustion space of at least 500 to 600 cubic meters per 1000 square meters of boiler surface (1.6 to 2 cu. ft. per 1000 sq. ft.) with the heat liberation which is used today. From that, the necessity of increasing the rate of heat liberation becomes clear. But since the rate of heat liberation is inversely proportional to the combustion time, we must proceed on the path of reducing the combustion time.

TABLE II. RELATION BETWEEN THE RATE OF HEAT LIBERATION AND SIZE OF COAL PARTICLES

Side of Cube	Heat Liberation		Side of Cube	Heat Liberation	
Microns	kcal/m³/h	Btu/ft³/hr	Microns	kcal/m³/h	Btu/ft²/hr.
10	24,700,000	2,770,000	110	330,000	37,000
20	7,100,000	796,000	120	282,000	31,600
30	3,420,000	384,000	130	242,500	27,100
40	2,035,000	228,000	140	213,500	23,100
50	1,362,000	153,000	150	188,500	21,100
60	983,000	110,400	160	168,000	18,850
70	744,000	83,500	170	150,500	16,900
80	585,000	65,600	180	136,000	15,250
90	473,000	53,100	190	122,500	13,750
100	391,000	43,800	200	112,500	12,600

Meaning of Combustion Time

Again, we must procure a clear definition of the term which we wish to improve. The term "combustion time" is only the expression of a collective function of many, partly independent, partly interconnected, variables; a collective term which has in it the velocity of many physical and chemical reactions, which cannot be expressed mathematically and have in fact not yet been investigated chemically. But even if we cannot look into the manifold details of this phenomenon, we can pick out the three important influences upon which the combustion time depends and their influences can be investigated at least qualitatively.

These three factors are: Fineness of powder (St), Temperature (T) and the entirety of the hydrodynamic and aerodynamic processes in the combustion chamber (Ac). The combustion time and therefore the heat liberation, as well, can generally be expressed as a function of these three variables.

Combustion time becomes less as the size of grain decreases. The relation between combustion time and size of grain can be expressed as the equation of a general hyperbola of the form

$$Z = \frac{C}{\left(\frac{F}{G}\right)^m} \qquad (6)$$

in which Z is the combustion time in seconds; C is a constant; F the geometric surface of the dust particle. G is the weight of the particle, and m is an exponent.

Only one important question can be answered today, namely to what extent can the heat liberation in the combustion space be raised by an increase in fineness, making the reservation that by the simple increase in fineness, temperature and turbulence in the combustion space shall not be changed. The analysis given in Table II is based on a bituminous coal of 7000 calories per kilogram (12,600 B.t.u. per lb.), a specific gravity of 1.2, excess air ratio of 1.25 and experimentally determined coefficients used in a modification of Equation 6.

The length of side of the coarsest dust particles is determined by screening. The table confirms the selected values correspond to present day conditions of powdered coal boilers in which the powder leaves no residue on German screen No. 30 (Tyler No. 65), and in which rates of heat liberation between 100,000 and 200,000 calories per cubic meter an hour (11,000 and 22,000 B.t.u. per cu. ft. per hr.) are the rule. The tabulation

also shows that in agreement with the nature of an exponental function the increase in rate of heat liberation becomes faster and faster with smaller length of side of the cube.

Empirical Law Holds Only for Limited Range

But it is questionable whether, for smaller lengths of sides of the cube, the empirically found law is still valid or whether the limits have not already been exceeded. Beginning with a certain fineness, the rate of heat liberation can be raised as high as we please, without bringing in the requirement of an especially great increase in fineness. But this means that no longer does any relation between fineness and rate of heat liberation exist, and that vice versa an increase of fineness alone has no influence any more on the rate of heat liberation.

From a certain fineness onward, we can obtain any desired rate of heat liberation as long as the other two variables, temperature and turbulence, permit. The question then is where the limits of fineness lie for practical application. According to the tabulation, the two million limit is exceeded only at 40 mu that is to say with a length of side which lies below that of the United States screen No. 325. It is not necessary that all of the dust pass through the screen without residue. On the contrary it is permissible to work with a certain residue and in consequence with a loss of potential heat, if thereby we obtain this high rate of heat liberation and if the loss caused by incomplete combustion is balanced by the lower first cost due to the higher rate of heat liberation or difficulties due to slag.

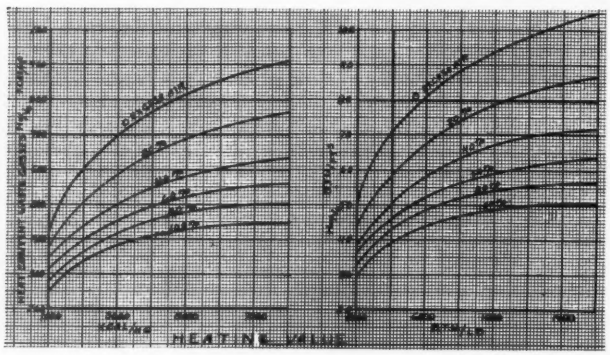


FIG. 1. HEAT CONTENT OF WASTE GASES PER UNIT VOLUME

Ignition Delay Must Be Shortened

While processes of combustion go on at the surface, heat conduction to the interior is continued and there in a progressive manner the completion of the pyrogenic decomposition takes place. On the basis of a predicted combustion line we can answer the question whether a complete or almost complete degasification takes place ahead of the ignition of the coal particles. The transformation into readiness for combustion is a process which, depending mainly on the thermal conductivity of the fuel requires a definite time. As a consequence of this fact, we observe in an even more pronounced manner than with solid injection Diesel engines or in oil furnaces, the phenomenon of delayed ignition or time-lag.

From observations of powdered coal combustion in actual practice, ignition delay has been determined to be approximately 0.05 to 0.2 seconds. The figures show, however, that, just as in Diesel engines evaporation of the oil during the delayed ignition can occur only to a very small extent, just so degasification of the dust ahead of the ignition reaches only a very low value and must be limited to the surface; for the duration of the delayed ignition is much too short to have pyrogenic decomposition occur to a noteworthy degree in consideration of the poor heat conductivity of the coal.

Since for high combustion rates only fractions of a second are available for combustion, it is easily recognized that great importance must be attached to the ignition delay and to the means of reducing it; therefore, shortening of the ignition delay becomes a most important problem in curtailing the combustion period.

In former days, the opinion used to be that high rates of heat liberation could only be obtained by highest possible furnace-temperatures, because engineers tried to obtain acceleration of reaction by means of high temperatures, and took no notice whatsoever of the influence of lowering the temperature on the combustion rate. In this attempt, the well-known difficulties with refractory material were also encountered for the overcoming of which a huge amount of work was carried out. But the problem is not to keep the temperature in the furnace as high as possible, but to lower it as far as possible, and in spite of this not to diminish the reaction-velocity.

Combustion always takes place almost at the theoretical limit temperature, that is to say, independently of the temperature of the furnace, while the giving off of heat to the surrounding parts takes place immediately afterwards but still only as secondary process after a short interval of time; therefore the gas-temperature of the furnace has less influence on combustion than on conversion for combustion readiness.

We must lower the gas-temperature in the furnace as far as possible by directly giving off heat but, in spite of this, not influence the velocity of conversion. For this problem exist different solutions. The first and most usual one consists in maintaining a most favorable equilibrium temperature, above all by making the cooling surface of the furnace only sufficiently large to keep the furnace temperature from dropping below the required level.

But this way does not lead far, for, according to my investigations, one should not go below 1200 deg. C. (2200 deg. F.) in the case of Westphalian bituminous coal, with about 30 per cent volatile matter, in the case of hard coal not under 1300 deg. (2375 deg. F.) and in the case of German brown coal not under 1100 deg. C. (2000 deg. F.) if the combustion has not become too slow. Certainly a perceptible increase of heat liberation is attained hereby but, as the ignition delay can hereby rise to 0.3 sec., there is soon a limit put to liberating more heat in this manner.

A second way is preheating the primary air as far as possible, while a third way, which has not yet been taken up in the case of powdered coal, consists of preheating the fuel by making use of ignition chambers, which are known from solid injection Diesel engines.

The most effective means for accelerating combustion consists in violent destruction of the separating

layers of coal and air by lively relative motion between the solids and the gases. Relative movements in all their aero- or hydrodynamic forms are called turbulence. In the case of dust-firing, the relative velocity is smaller the finer the dust is ground. It is a well-known fact that from a certain limit onwards separation of the dust from the gases does not take place and that the necessity of turbulence is therefore the more pressing the greater the fineness of the dust.

Many Problems Yet Unsolved

Conversion and combustion are complicated processes, composed of all kinds of reactions, the course of which is determined by the influence of fineness, temperature and turbulence, as already depicted. It is, therefore, quite impossible to pick out one single point of this exceedingly unstable process as the ignition point and to call it a property of the fuel. It may be possible to determine physical ignition points in the laboratory under uniform conditions and to compare them with one another; however, even then we must realize that it does not depend on the fuel alone but on a number of influences outside of the fuel. For that reason, no comparable ignition points exist at all in technical furnace. The ignition point is rather only the resonance of the fuel on the events in its surroundings.

The result of these investigations is that with fine grinding, suitable temperature, preheating and turbulence, very short combustion time can be obtained. But what that statement the problem is not yet solved, for we meet with all kinds of obstructions and limitations when pursuing these measures. Any desired heat liberation can be obtained above a certain dust-fineness, and theoretically and technically there is no limit to fine grinding. But limits of an economical nature exist.

For grinding costs increase very rapidly to such a degree that the saving due to increased evaporation rates of the boiler plant is swallowed up. Even today, the grinding plant is a heavy burden for the economy of powdered coal firing, so that engineers endeavor to get along with the coarsest possible degree of grinding.

Heat Absorbing Capacity of the Boiler

The whole of the research concerned the problem of developing as high a number of calories as possible in the furnace but the problem of carrying this heat away in a useful manner is just as important. It turned out that lowered average gas-temperature was a necessary measure for increasing the combustion rate; therefore, the question is to be raised how fast heat can be transferred to the cooling surfaces of the furnace and what lowering of temperature is obtained thereby.

In Fig. 2, for the combustion of a bituminous coal of 7000 calories (12,500 B.t.u. per lb.) with 25 per cent excess air, it was assumed that five faces of the cubic furnace of a 1000 square meter (10,760-sq. ft.) boiler consist of heat-absorbing cooling-surfaces. The coefficient of heat transfer was assumed to have the high value of 200,000 calories per square meter per hour (73,500 B.t.u. per sq. ft. per hr.) the highest value hitherto measured on a coal dust furnace. It was calculated for different steaming rates from 25 to 100 kilograms per square meter per hour (5 to 20 lb. per sq. ft. per hr.). The lower part of the illustration shows the amount of developed heat which the cooling-surfaces can absorb. The upper part gives the actual furnace temperatures, which establish themselves in consequence of this loss of heat.

With the heat liberation rate of one million kilogram calories (112,100 B.t.u.) and 50 kilogram (10.4 B.t.u.) steaming rate the temperature is already 1360 deg. C. (2,480 deg. F.), and in the case of higher combustion rates, heat transfer causes only trivial lowering of temperature. But with that, the very effective measure of lowering the temperature drops out as long as one does not arrange the cooling surfaces in a very different manner. From this one recognizes the necessity of increasing the heat transfer to the cooling and heating surfaces. This velocity problem no longer concerns the combustion time but the cooling-period and is just as

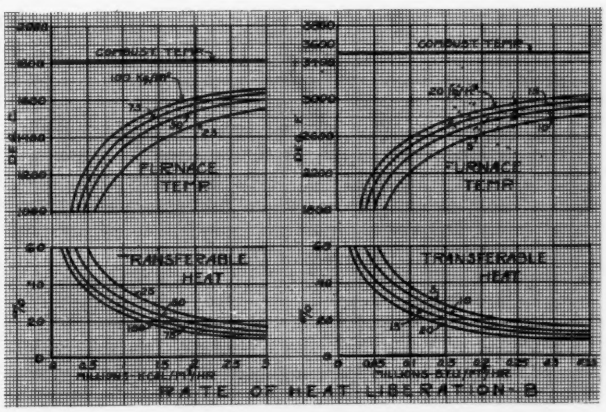


FIG. 2. HEAT TRANSFER IN A 1000 SQUARE METER (10,760-SQ. FT.) BOILER

important. Quick combustion is advantageous only if it is bound up with rapid heat-abstraction.

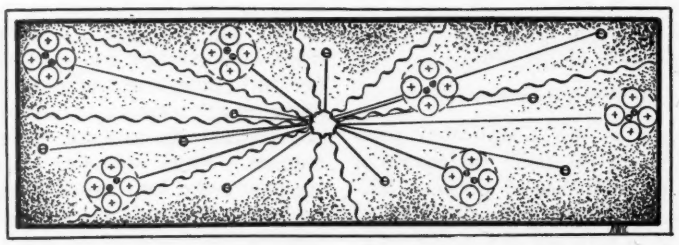
Conclusions

As grinding fineness soon reaches its economic limits and lowering of temperature can be achieved only with low rates of heat liberation, turbulence has to play the principal part. The products of combustion which are formed, must be carried away just the same as the developed heat. These limits of heat liberation are determined by the permissible or attainable gas-velocity. The theoretical limit of the gas-flow is reached at the velocity of sound and it may be mentioned here only that this velocity corresponds to a heat liberation of about 100 million calories per cubic meter per hour (11 million B.t.u. per cu. ft. per hr.). Even if here the theoretical limits lie far beyond practical endeavors, still attention must be called to the fact that combustion time, maximum heat liberation, furnace-size and gas-velocity are bound together in conformity to natural thermodynamic laws, which should not be lost sight of during design.

Investigation of the thermal foundations thus shows dust-firing to be decidedly a velocity problem. Theoretically, the maximum heat liberation of the furnace is inversely proportional to the combustion time and the latter itself is a complicated function of dust-fineness, temperature and the aerodynamic relations of the furnace. Practically, it depends on the velocity of heat transmission to the boiler tubes.

Electricity—What It Is and How It Acts*

PART XXXVI



BY A. W. KRAMER

Preliminary Considerations of Radioactive Phenomena. Its History and Fundamental Significance.

WE HAVE NOW described the fundamental principles involved in the production of two types of radiations, first those known to us as visible light and X-rays and second, those which we commonly term radio waves. The first type owes its origin to changes in the position or energy levels of the external electrons in the atom; the second, to the motion of free electrons in conductors. Both of these types of radiation are produced at will by man.

Now, however, we come to a type of radiation which, while it may be classified as a form of X-ray, is very much more penetrating than the usual X-ray and so far, at least, has not been capable of being produced by man. This is the so-called gamma ray of radium. As shown on the scale of electromagnetic radiation,[1] these rays are much shorter than X-rays and have a correspondingly higher frequency.

Before we can discuss the production of these rays, it will be necessary to consider the more general aspects of radio-activity or that phenomenon associated with radioactive substances. Radioactivity, although not considered an electrical phenomenon in the ordinary sense, is nevertheless, fundamentally electrical in nature. It is intimately associated with the action of the electron and the proton and for this reason it will be to our advantage to study this phenomenon which has not only provided us with a marvelous tool for further researches into electricity but has changed entirely our conception of matter. To radium more perhaps than anything else we owe much of our present knowledge of atomic structure and of the energy relations within the atom. This has come about in two ways: first, through a careful study of the disintegration processes which all radioactive elements undergo, and second, by using as projectiles, the tiny particles shot out from radioactive elements to probe the interior of other atoms.

Radioactivity a Phenomenon of Substances of High Atomic Weight

Radioactivity deals with phenomena exhibited by a special class of substances of high atomic weight of which uranium, thorium, radium and activium are the best known examples. These substances possess the property of spontaneously emitting radiations of a special character which will penetrate bodies opaque to light. The emission of these radiations is accompanied by, or rather we should say is the result of, disintegration of the atoms of the radioactive substance into a substance of lower order in the scale of atomic weight.

The discovery of radioactivity was one of the most revolutionary in the entire history of science, for it compelled us to change all our conceptions of matter and its relation to energy. Not only has it exerted a profound effect upon scientific theories but upon human thought as well. For it demonstrated that the principle of universal change so apparent in all aspects of nature extended to the very elements themselves. Since the futile attempts of the alchemists, the elements had always been regarded as immutable. Now they were shown not only changeable but the process apparently was going on spontaneously! That such an astonishing discovery should have had far reaching consequences is not strange.

Before the discovery of radioactivity, our knowledge of the elements was extremely superficial. True, much was known of chemical reactions and by the periodic law, the known elements had been classified according to their atomic weights.[2] The atoms, it was known, were the "bricks" of which the universe was constructed and, while much was known as to the results effected through various combinations of these "bricks," little or nothing was known of the "bricks" themselves. Atoms were thought to be indivisible. Although as shown in the first chapter of this series, many suspected that atoms might

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[1]Part XXVI, August 15, 1929 issue, p. 896.

[2]The periodic law or periodic system was enunciated about 1871 by a Russian, D. I. Mendeléeff. In this system, all the elements are arranged successively in the order of their increasing atomic weights and divided into eight groups, as shown in the accompanying table. When Mendeléeff so arranged the elements, a repetition of properties was observed, the elements in each group having similar properties. From 1894-1898, several new elements were discovered in the atmosphere. These were the inert gases or the Helium family. In modern tables such as shown here, these elements are placed in group O, therefore making a table of 9 groups in all, the last group having elements arranged in triads having atomic weights of nearly the same value. Hydrogen does not fit into the periodic system. By means of this law, it was possible to predict new elements. In 1871, Mendeléeff actually predicted the properties of three new elements which he called Eka-aluminum, Eka-boron and Eka-silicon. In less than 20 yr., Mendeléeff's bold prediction was complete, as all these elements were discovered and found to have almost exactly the properties predicted for them.

be composed of still smaller particles. Had one ventured to predict radium 40 years ago, however, he would have been told not only that such a thing was improbable but that such a thing was opposed to all the established principles of matter and energy.

As Soddy[3] puts it, if one were to demonstrate to an architect or contractor, that the bricks he habitually and properly employs in the construction of his buildings were under other circumstances, capable of entirely different uses, say, for instance, of being used as explosives incomparably more powerful than dynamite, his surprise and astonishment would be no greater than was the chemists' at the new and undreamed of possibilities of matter as demonstrated by the mere existence of such an element as radium.

Radioactivity Discovered by Becquerel

Radioactivity dates back to 1896 and was an indirect consequence of the discovery of X-rays by Röentgen several months before. It was known that the production of X-rays in a vacuum tube was accompanied by a strong phosphorescence of the glass and it occurred to several investigators that ordinary substances made phosphorescent by light might also yield a penetrating radiation similar to X-rays.

Acting on this theory, Henri Becquerel, the distinguished French physicist, exposed among other substances, a phosphorescent compound of uranium to a photographic plate wrapped in black paper. This was done in sunlight. By this means he obtained a weak photographic effect. Evidently the uranium compound when excited into phosporescence by sunlight, emitted a radiation similar to X-rays.

One day, however, the sun was obscured and the photographic plate and the phosphorescent uranium were placed in a dark drawer for several weeks and afterward, Becquerel, wishing to see if any darkening had occurred without sunlight, developed the plate as it was. Much to his astonishment, he found that the darkening had gone on just as much in darkness as it had in light. Further experiments proved that neither sunlight nor phosphorescence had anything to do with the experiment. The action was due to an *entirely new inherent property of uranium.*

Subsequently other effects were noted. Becquerel showed that this radiation emanating from these uranium compounds, was capable of discharging an electrically charged body whether electrified positively or negatively. They were shown to render air or other gases in the vicinity conducting just as would X-rays. Thus, the radioactive substance when brought near a charged gold leaf electroscope caused a rapid collapse of the gold leaves. The process was also shown to be accompanied by the production of heat.

Mme. Curie's Discovery of Radium

Basing her experiments upon Becquerel's discovery of the electrical effect of uranium compounds, Mme. Curie made a systematic investigation of a large number of chemical elements, to determine whether any of them possessed the same radioactive effect that did uranium. It was in the course of these investigations that she discovered radium, which is some two million times more radioactive than uranium. Radium possessed all the properties of uranium but to a tremendously more powerful degree. Radium was extracted from pitchblende or uraninite, which the Austrian government generously provided for Mme. Curie from its extensive deposits at Joachimstahl.

While the "rays" from radium and other radioactive substances resemble X-rays in their ability to penetrate opaque matter, actually they are of three different types, which for want of better names have been named after

[3]The Interpretation of Radium, by Frederick Soddy.

THE PERIODIC TABLE OF THE ELEMENTS

Periodic Table*

Periods	Group 0	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Type of Oxide	—	R_2O	RO	R_2O_3	RO_2	R_2O_5	$R_2O_5(RO_3)$	R_2O_7	RO_4
Type of Hydride	—	RH	RH_2	RH_3	RH_4	RH_3	RH_2	RH	—
		A B	A B	A B	A B	A B	A B	A B	
First short period	He 2 4.002	H 1 1.008 Li 3 6.94	Be 4 9.02	B 5 10.82	C 6 12.00	N 7 14.01	O 8 16.00	F 9 19.0	
Second short period	Ne 10 20.183	Na 11 23	Mg 12 24.32	Al 13 26.97	Si 14 28.06	P 15 31.03	S 16 32.06	Cl 17 35.46	
First long period, Even Series	A 18 39.94	K 19 39.1	Ca 20 40.07	Sc 21 45.1	Ti 22 47.9	V 23 50.96	Cr 24 52.01	Mn 25 54 93	Fe 26 Co 27 Ni 28 55.84 58.94 58.69
First long period, Odd Series		Cu 29 63.57	Zn 30 65.38	Ga 31 69.72	Ge 32 72.6	As 33 74.96	Se 34 79.2	Br 35 79.92	
Second long period, Even Series	Kr 36 82 9	Rb 37 85 44	Sr 38 87 63	Y 39 88.92	Zr 40 91.22	Cb 41 93 1	Mo 42 96.0	Ma 43 ?	Ru 44 Rh 45 Pd 46 101 7 102.91 106.7
Second long period, Odd Series		Ag 47 107.88	Cd 48 112.41	In 49 114.8	Sn 50 118.7	Sb 51 121.77	Te 52 127.5	I 53 126.93	
Third long period, Even Series	Xe 54 130.2	Cs 55 132.81	Ba 56 137.37	La 57 138.9	Ce 58 140.25				
Third long period, Odd Series			The Rare Earth Elements. Atomic Numbers 59–71						
Fourth long period, Even Series					Hf 72 178.6	Ta 73 181.5	W 74 184.0	Re 75 ?	Os 76 Ir 77 Pt 78 190 8 193 1 195.23
Fourth long period, Odd Series		Au 79 197.2	Hg 80 200.61	Tl 81 204.39	Pb 82 207.22	Bi 83 209.0	Po 84	—85	
Fifth period	Rn 86 222	—87	Ra 88 225.95	Ac 89	Th 90 232.15	UX_2 91	U 92 238.17		

* The number at the right of the symbol is the Atomic Number of the element, and the number below is the Atomic Weight.

the first three letters of the Greek alphabet, "Alpha" (α) rays, "Beta" (β) rays, and "Gamma" (γ) rays. These will be considered in detail later.

Now, although it is true that all of the effects which characterize radioactive phenomena can be produced by other means, in radioactive substances they occur spontaneously and without interruption.

It is because of this spontaneous emission of energy (for these rays constitute energy just as any other form of radiation constitutes energy) that the radioactive process is so unique and without analogy in science. Heat and light may be obtained in numerous ways but it is a new thing to find them being given out by a substance, as they are by radium, year in, year out without apparent intermission or diminution.

How is it possible for energy to evolve out of nothing? When we burn coal or carbon, energy is released in the form of heat, but the carbon disappears, that is, it combines with the oxygen of the air, to form CO_2. In other words, while in the form of coal, the carbon possessed a certain amount of potential energy by virtue of its affinity for oxygen. During the process of combining with the oxygen, this potential energy is released.

But with radium there seemed to be no such combustion. Energy was being evolved at an enormous rate, far greater than that obtained by the combustion of carbon, yet apparently without diminution of the quantity of radium involved. So long as radioactivity was known only on the scale and in the degree exhibited by uranium, it was possible to explain away this aspect of a continuous emission of energy because of the minuteness of the amount involved and the difficulty of proving that it was not due to some extraneous cause. But when radium was finally isolated by Madam Curie, the amount of energy released was so enormous as to preclude uncertainty.

The Secret of Radioactivity Lies in Atomic Changes

The answer to this astonishing phenomenon, we know today, rests in the atom itself—in the dissatisfaction, so to speak, of the electrons and the protons of which the atom is composed. We have seen, in the first part of this series, that all atoms consist of electrons and protons, the configuration and number of these components determining the properties of the atoms of different elements. Thus hydrogen consists of a nucleus consisting of a single proton and a single planetary electron. Helium, it was shown,[4] consists of a more complicated nucleus and two planetary electrons.

Also, it was shown that while the number of external or planetary electrons in a normal atom is always the same for the atoms of a definite substance, the characteristics of an atom are really determined by the resultant charge on the nucleus. The external electrons exist by virtue of the charge on the nucleus and if one or more of them are removed by rubbing or other means of ionization, the atom remains unchanged except that it now carries a charge.

It was shown, further, that the number of external electrons which an atom carries normally is determined not by the total number of electrons and protons in the nucleus, but by the difference between the number of each. If a single proton or a single electron could be removed from the nucleus of an atom, we would change the resultant charge of the nucleus by one, and the atom would no longer exhibit the same characteristics and properties it did before the change was made. If, however, we removed both an electron and a proton from the nucleus, the resultant charge would remain unchanged and the characteristics of the atom would remain unchanged. The weight of the atom would, however, be changed. Thus systems with the same atomic number may have different atomic weights. Such systems are called isotopes.

By means of X-rays or electron bombardment, we have seen that it is possible to remove external electrons from an atom,[5] but by no possible means have we been able to remove either electrons or protons from the nucleus of an atom. These, it seems, are locked in the nucleus so tightly that no concentration of energy man has been able to direct is capable of dislodging them.

It is in such nuclear changes, however, that we find the reason for radioactive phenomenon. In radioactive materials, radium, uranium, thorium, etc., such nuclear changes occur spontaneously. Electrons and protons are ejected from the nuclei of such atoms with tremendous energy. These protons and electrons, shot out, so to speak, from the nuclei of these atoms with terrific velocity, manifest themselves as rays.

Radioactive substances have been defined as atomic systems dissatisfied in their nuclear structures. We have seen, in our study of the external electrons, how atoms of some substances were more stable than others and how, because of such instability in some atoms, certain laws of chemical combination can be explained. In radioactive materials, it is the nucleus of the atom that is unstable. Eventually such a condition of instability leads to a disruption of the nucleus and certain parts are ejected. After such a change, an atom is generally declassed; that is, it moves down in the scale in the periodic table.

It is to a consideration of these changes and the respective parts they play in giving rise to the various radioactive phenomena that we will apply ourselves. In the several succeeding articles, these changes will be discussed in detail.

[4] Chapter II. Electricity—What It Is and How It Acts, Vol. I.

[5] In the phenomenon of ionization.

Electricity in commercial form is obtained from three sources: by the combustion of gas, oil, coal or wood; from falling water and from chemical reactions as in batteries. Of the three, the first is the most important and produces the bulk of the electricity used in this country.

Streams are not always desirable for water power development, even though the necessary fall is present. Niagara is an ideal development because nearly the maximum flow is available throughout the year. Many streams, most of those in the middle west included, are of the flashy type with long periods of little or no flow and frequent periods of high water. Utilization of these steams is expensive because the overhead on idle plants during periods of low water is high.

In the usual design of rotary piston pumps, the piston or rotor is placed eccentrically in a cylinder which is divided into two chambers.

Heat Resisting Metal Finds New Uses

By Dr. Carl Commentz

PARTS WHICH ARE EXPOSED to heated gases without being cooled on the other side by fluids tend to burn and warp within a short time. This is due to the oxide scale which is formed on their surface. It has a different coefficient of heat expansion from that of the metal itself and if contraction from a colder temperature arises, the scale layers separate from the metal, so that at a new heating a fresh metallic surface is exposed to the gases.

In order to avoid this repeated burning of the metallic surface, a process has been developed and introduced with good success in Germany during the last year. It is based upon the fact that iron-aluminum alloys form, when exposed to hot gases, a scale which has the same coefficient of heat expansion as the alloy itself, so that the scale does not separate from the metal but sticks firmly to it. The cover is applied to the surface of steel and iron by spraying a thin cover of aluminum to it. This is coated with a special air excluding cover and exposed to a heat of 2000 deg. F. At this heat, the aluminum goes into the steel and the steel into the aluminum, so that an alloy layer about 1/40 in. thick is formed.

This process has found application especially for the grates of railway engines. The German railways have made embracing investigations and have found out, that the lifetime of the grates was increased fivefold in the boiler of an express train engine. In marine boilers grates with the new alloy cover have given satisfactory results. Slag sticks much less to covered bars than to noncovered bars, so that it is easier to keep clean fires.

Investigations were made some years ago at a large Hamburg yard to select the best heat resisting materials for the guide plates in boiler superheaters and for the fastenings of the superheater tubes. The new process met the requirements. Then the fastenings and baffles of the superheaters of the boilers of a large 30,000-t. steamer were made of mild steel with the alloy covering and later on the same parts in the boiler plants of the Bremen and the Europa, the North German Lloyds new liners, have been made of alumeted material. In all in these vessels, about 80,000 sq. ft. of boiler material have been covered by the alumetation process. Superheaters themselves have been alumetated of late for a large stationary boiler plant.

Trials have been made also at the tubes of large marine water-tube boilers. Three years ago 10 alumetated tubes were put into such boilers and at the same time a number of uncovered tubes were renewed. The new uncovered tubes in the lowest row had to be renewed partially after 3 or 4 mo. service, while, with the exception of one, the alumetated tubes were still doing satisfactory service after 3 yr. A careful investigation of the non-covered tubes, which failed, showed that they were especially worn at the outside and their wall thickness had been reduced from 4 to 2.5 mm. The wear and tear at the outside had been caused by thermal, mechanical and chemical influence of the flame gases and as a consequence of this deterioration, the inner steam pressure had deformed the tubes, so that the scale broke off and there arose tensions in the material, which caused corrosion grooves in the inside.

This investigation shows that the outside protection of tubes under pressure also delays inner corrosion. The alumetation process applied to water tubes for boilers must, however, be made in a more complicated way, as the cover must be able to resist bending in cold state; parts that are alumetated in the normal way do not stand any bending or rolling in cold state.

Scientist to be Chosen for $10,000 Award

Largest single monetary award in America for scientific accomplishment has been created by Popular Science Monthly, which, beginning this autumn, will confer an annual prize of $10,000, accompanied by a gold medal, upon the American citizen who has been responsible, during the preceding year, for the achievement in science of greatest potential value to the world.

It is explained that the award is intended to heighten the interest of the American people in those conquests of the laboratory and the workshop which benefit the entire community and to focus attention upon the many scientific workers who, without thought of personal profit, toil to better man's control over his physical surroundings.

The Popular Science Institute has enlisted twenty-four leaders in American science to serve as a Committee of Award. The distinguished men comprising the Committee of Award include the following members of the American Society of Mechanical Engineers: Prof. Collins P. Bliss, director, Popular Science Institute; Dr. Harvey N. Davis, president, Stevens Institute of Technology; Charles F. Kettering, president, General Motors Research Corp.; Dr. Arthur D. Little, president, Arthur D. Little, Inc.; Dr. Elmer A. Sperry, chairman, board of directors, Sperry Gyroscope Co.; Dr. Samuel W. Stratton, president, Massachusetts Institute of Technology; Henry Herman Westinghouse, chairman, board of directors, Westinghouse Airbrake Co.; Dr. Albert E. White, director, Department of Engineering Research, University of Michigan; and Orville Wright, co-inventor of the airplane.

New orders booked during the fourth quarter of 1929, as reported to the Department of Commerce by 81 manufacturers of electrical goods, were $288,736,209, as compared with $338,169,678 for the third quarter of 1929 and $282,226,449 for the fourth quarter of 1928. Total bookings for 1929 amounted to $1,290,193,618, an increase of 25 per cent over the $1,029,721,508 of orders booked in the previous year.

Present steam and combustion cycles have about reached their limit of development and it is expected that further improvements will come through the discovery or development of new cycles. Low and high-temperature coal carbonization plants in conjunction with power plants and binary vapor cycles seem to be the most promising at present. The most efficient steam plants use a combustion reheat-regenerative cycle and heat economies as low as 12,500 B.t.u. has been obtained in practice.

High Efficiency Obtained from Wood Waste Fuel

TESTS MADE BY THE ASSOCIATION OF POWER AND FUEL ECONOMY IN BOILER PLANT OF ENSO-GUTZEIT OSAKEYHTIO, FINLAND, SHOW EFFICIENCIES OF 85 PER CENT WHEN USING WET WOOD WASTE. BY K. P. MYKKÄNEN*

SOMEWHAT OVER 20 million cubic feet of wood waste is burned each year in the boiler plant of the Enso Mills of the Enso-Gutzeit Osakeyhtio at Enso, Finland. This material consists of about 50 per cent sawdust and 50 per cent chips, bark and other wood waste.

The boiler plant, wood waste handling arrangements and some operating results for a period of three years were given in some detail on page 742 of the July 1, 1929 issue of Power Plant Engineering. Five of the boilers are 528-hp. B. & W. units with 122-sq. ft. horizontal grates of which Fig. 3 is typical. The sixth unit, which was just being completed at the time of the previous article, is a 538-hp. Krupp boiler with a 341-sq. ft. step grate as shown in Fig. 4.

In order to determine the maximum capacity and best efficiency of the two units, a series of seven tests were made by the Association of Power and Fuel Economy of Helsinki. Data and calculations of the tests are tabulated in the accompanying table and the results plotted in Figs. 1 and 2.

*Power and Electrical Engineer, Enso Mills, Enso-Gutzeit Osakeyhtio, Suomi-Finland.

Altogether, four tests were made on boiler No. 5: with 2.99; 5.71; 8.28 and 9.03 kg/m²/hour loading or reduced to evaporation from and at 212 deg. F. 3.42; 6.82; 10.13 and 11.07 lb. per sq. ft. per hr. respectively. The fuel used in all tests consisted of green sawmill waste and sawdust. The moisture content of the fuel varied in different tests from 53.8 to 56.75 per cent with an average moisture content of 55.4 per cent. The results in detail are to be found in the accompanying table and Fig. 2. The results can be considered as excellent. In criticizing the results, it must be remembered, however, that the boiler and all its parts were completely cleaned shortly before the tests were made. Before each test, the tubes were blown to remove soot and the grates cleaned from ash. In addition, it must be taken into consideration that the system is equipped with an air preheater and the added efficiency due to this is included. Test No. 7 shows the maximum average amount of steam that could be generated with this boiler, equipment and fuel used.

Efficiency at the maximum loading is more than likely too low by 3 or 4 per cent. This is shown by

TABULATED TEST DATA AND CALCULATED RESULTS OF SEVEN 8-HR. BOILER TESTS

Test No.		1	2	3	4	5	6	7
Boiler No.		3	3	3	5	5	5	5
Duration of test, hr. and min.		8:09	8:00	8:06	8:03	8:00	8:03	8:03
Fuel								
Heating value,	B.T.U./lb.	3090	2820	3010	2960	3100	3240	3020
Moisture,	%	55.4	58.4	56.3	56.75	55.2	53.8	55.9
Density,	#/cu.ft.	20.2	22.2	19.9	23.2	20.7	20.3	21.3
Fuel fired,	Cu.ft.	3320	5460	8300	2915	615	9240	11,170
Fuel fired,	lb.	67,300	121,000	165,500	67,800	127,100	184,000	238,000
Fuel fired,	lb./hr.	8.260	15.160	20.450	8.440	15.880	23.360	29.530
Fuel per unit of grate area,	#/hr.	47.9	88	118.5	24.7	46.5	67.9	88.6
Fuel per unit of boiler surf.,	#/hr.	1.55	2.86	3.74	15.52	2.94	4.32	54.8
Feedwater								
Evap. total lb.		133,400	208,400	302,200	130,000	246,200	359,800	391,500
Evap.,		16,380	26,100	37,350	161,300	30,800	44,650	48,500
Unit evap.	#/sq.ft.	3.09	4.93	7.06	2.99	5.71	8.28	9.03
Unit evap. f.&a. 212°F.	#/sq.ft.	3.60	5.92	8.59	3.42	6.82	10.13	11.07
Temp. to economizer,	°F.	73.0	70.3	72	72	60.1	57.9	57.1
Temp. to boiler,	°F.	208	202	196	242	242	252	267.3
Steam								
Pressure,	#/sq.in.ga.	229	235	237	220	227	233	231
Temp. leaving superheater,	°F.	592	648	666	615	732	784	811
Heat abs. in boiler,	B.T.U./lb.	1022	1029	1034	987	979	980	961
Heat abs. in superheater,	B.T.U./lb.	124	143	752	126	188	217	229
Total heat absorbed,	B.T.U./lb.	1146	1172	1186	1113	1167	1197	1190
Flue gas analysis								
Economizer outlet, CO_2	%	12.8	12.8	13.3	17.5	15.8	15.7	15.5
Economizer outlet, (CO_2 + O_2)	%	20.1	20.1	20.0	20.0	20.0	20.0	20.1
Economizer outlet, CO	%	-	-	0.1	0.1	0.1	0.1	-
Economizer outlet, excess air	%	55	55	45	15	25	25	25
Economizer outlet, temperature,	°F.	327	406	468	259	333	401	432
Air temperature,	°F.	178	190	196	118	162	169	180
Draft leaving econ. outlet,	In. water	0.24	0.85	1.46	.06	0.31	0.88	1.69
Steam generation								
Actual,	#steam/#fuel	1.985	1.721	1.825	1.918	1.936	1.920	1.646
f.&a. 212°F.	#steam/#fuel	2.317	2.070	2.223	2.195	2.316	2.372	2.013
Heat balance								
Boiler,	%	66.0	63.1	62.7	63.9	60.9	58.1	52.1
Superheater,	%	7.4	8.8	9.2	8.3	11.7	12.7	12.4
Economizer,	%	8.7	8.1	7.5	11.0	12.0	11.5	11.4
Total absorbed,	%	82.1	80.0	79.4	83.2	84.6	82.3	75.9
To chimney	%	7.0	10.3	10.7	5.4	6.1	9.4	10.8
Unburned gas, radiation, etc.	%	10.9	9.7	9.9	11.4	9.3	8.3	13.3
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0

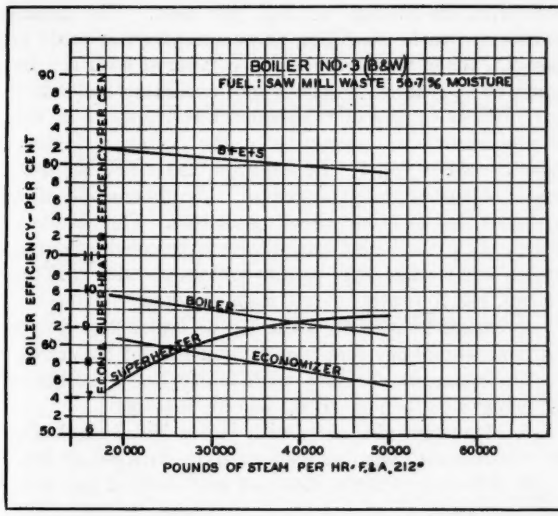

FIG. 1. EFFICIENCY CURVES DRAWN FROM THE THREE TESTS MADE ON NO. 3 BOILER

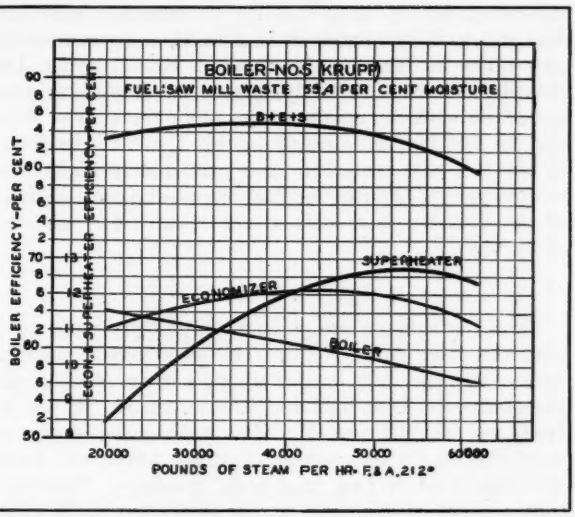

FIG. 2. EFFICIENCY CURVES DRAWN FROM THE FOUR TESTS MADE ON NO. 5 BOILER

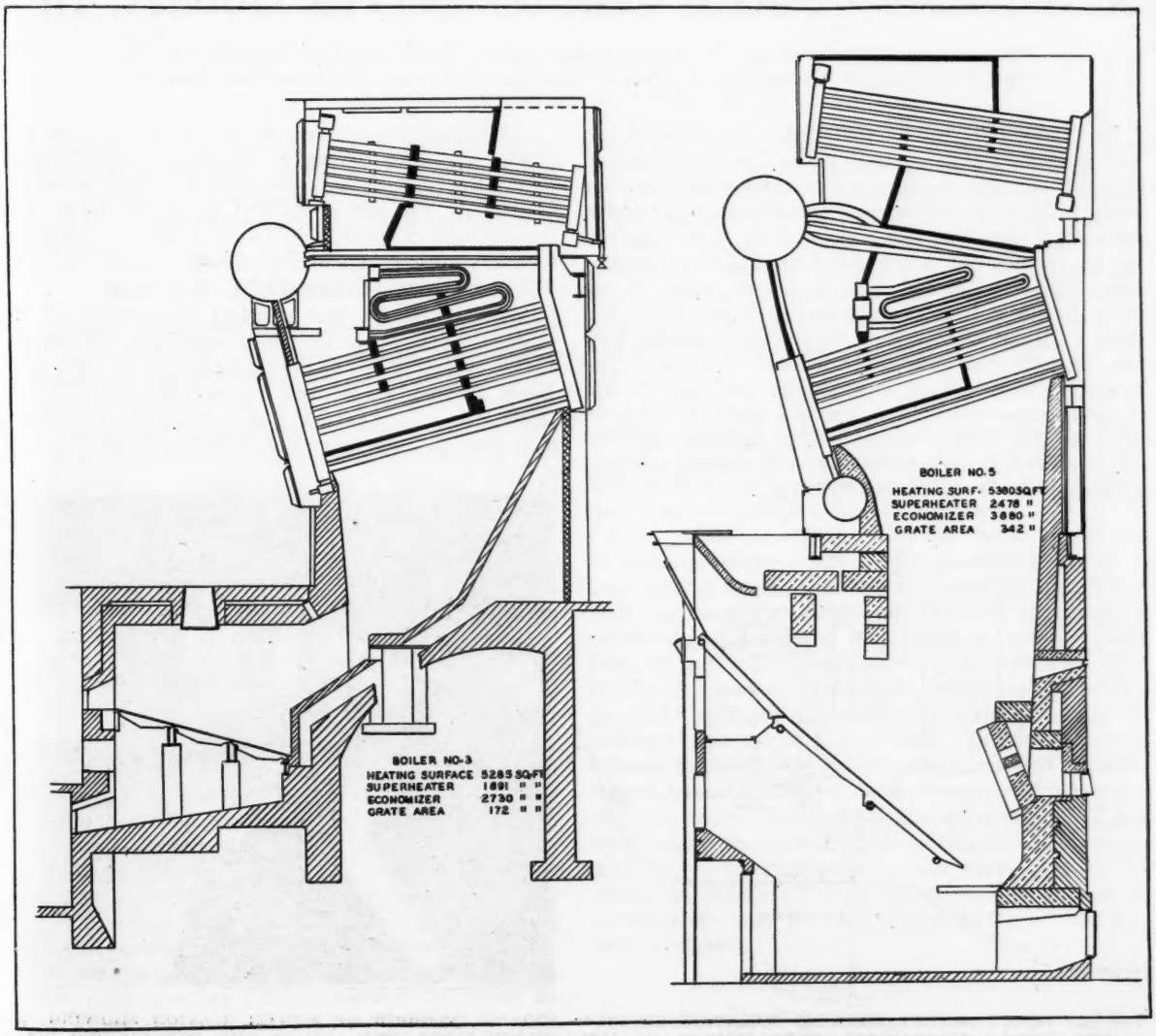

FIG. 3. CROSS-SECTION OF B. & W. BOILER AND FURNACE NO. 3 EQUIPPED WITH HORIZONTAL GRATES

FIG. 4. CROSS-SECTION OF KRUPP BOILER AND FURNACE NO. 5 EQUIPPED WITH STEP GRATES

the comparatively large loss due to unburned gases and fuel which, if calculated in heat units, is approximately two times as large as in the test No. 6, which last mentioned seem to be fairly close to the true value when compared with the results of the other tests. The cause for the less favorable result in this test is to be found in the fact that sometimes and particularly during the middle part of the run the fuel consisted almost entirely of sawdust, which as such is not suitable for this type of furnace.

Boiler No. 3 (B. & W.)

For the sake of comparison, three tests were made with the older boiler No. 3. The tests were made with 3.09; 4.93; and 7.06 lb. per sq. ft. per hr. loading corresponding to 3.60; 5.92 and 8.59 lb. per sq. ft. per hr. from and at 212 deg. F. The last-mentioned figures show the maximum amount of steam which the boiler with this kind of fuel used could generate. The moisture content of the fuel varied from 55.4 to 58.4 per cent with an average of 56.7 per cent. The detailed results are to be found in the accompanying table and Fig. 1. When these results are compared with the foregoing ones, it must be taken into consideration that the last inside cleaning of this boiler was some two or three months previous, consequently the boiler was not as clean as boiler No. 5. In addition, there are big differences in the types of furnaces, the dimensions of the furnaces and in other affecting factors. The results obtained with this boiler can, however, be considered good.

In comparing the results obtained with different boilers, the following points may be noted:

1. Steam generating capacity of boiler No. 5 is approximately 30 per cent higher than that of boiler No. 3.
2. Maximum efficiency with boiler No. 5 is obtained by using 6.15 lb. per sq. ft. per hr. loading.
3. Maximum efficiency with boiler No. 3 is obtained by considerably smaller loading than with boiler No. 5.
4. Efficiency curves obtained with both of the boilers are very even.

New Diesel Central Station Serves Hobart, Ind.

Features of This Pumping, Power and Light Plant Include Power Control and Distribution, Unique Water-Cooling System and Use of Alarms to Avoid Poor Operation

UNFILTERED WATER SUPPLY has retarded the growth of Hobart, Ind. With the completion of the million gallon a day capacity mechanical filtration plant, which is now being constructed close to the power generating plant and alongside of Deep River which is fed by springs and which has been dammed, forming what is now called Lake George, rapid growth is expected. It was with this expectation in mind that the excellent Diesel plant, which was started in operation on Dec. 28, 1929, was built for expansion. At present, the power units consist of two 560-hp. and one 360-hp. Diesel engines but provision has been made for the later addition of a 1200-hp. Diesel and for replacing the 360-hp. unit with a second 1200-hp. unit, making the ultimate capacity of the station 3520 hp.

At present, 1665 customers are served with light and power, the town having a population approximating 8000. Distribution lines are being extended which, on completion, will add about 300 hp. to the load. The present load is about 5000 kw-hr. a day but after the completion of the mechanical filtration plant this load will be increased to about 10,000 kw-hr. a day.

Another motive that impelled replacement of the original steam power by Diesel equipment was the excessive operating cost of the old steam plant which, after 25 yr., had become obsolete and in poor state of repair. Illustrative of the former high operating cost and the gain made by the change, it is necessary only to note

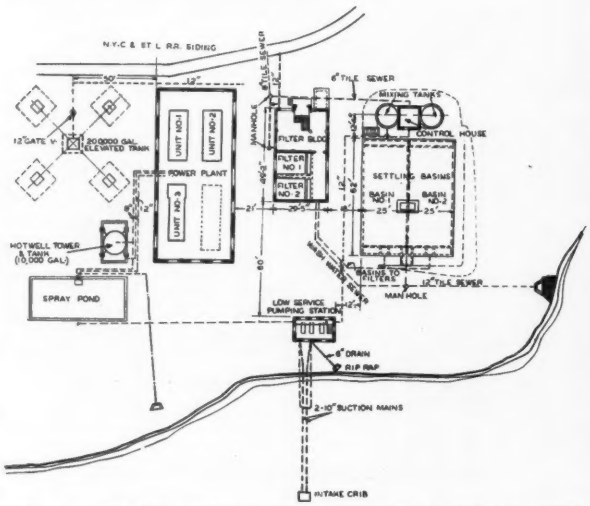

FIG. 1. PLANT LAYOUT SHOWING RELATION OF CITY WATER SUPPLY, MECHANICAL FILTRATION PLANT AND DIESEL POWER STATION

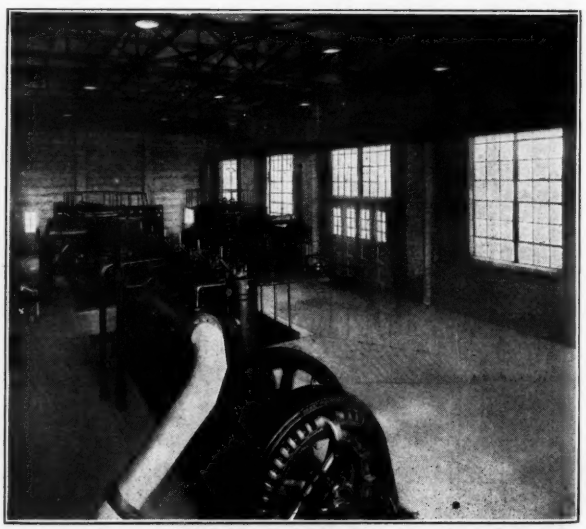

FIG. 2. INTERIOR OF POWER STATION SHOWING ALL THREE UNITS, THE ONE IN THE FOREGROUND BEING THE 360-HP. UNIT

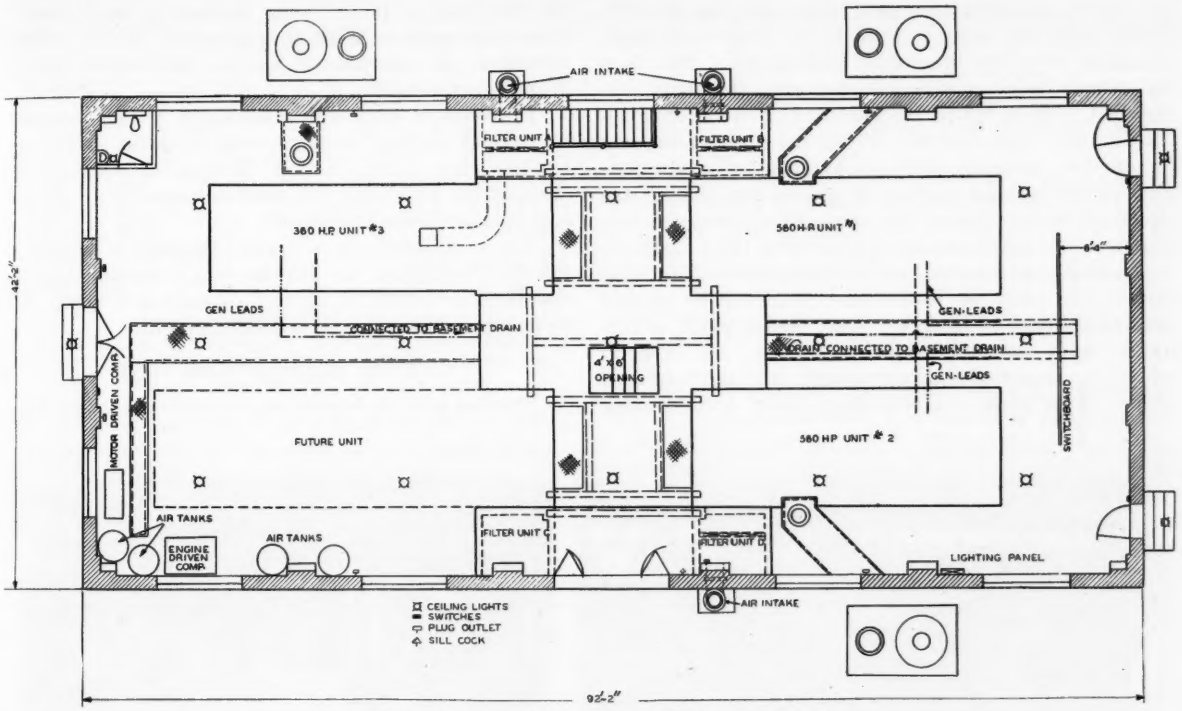

FIG. 3. LAYOUT OF DIESEL POWER STATION

that formerly 29 men were employed in the power plant while in the present plant, although its capacity is one-third greater, only four men are required. Coal was handled three times from the coal pile to the boilers in the old plant.

Engine Room Is Light and Airy

Although no expense was spared in supplying complete equipment for this plant and in substantially housing it, elaborate adornment of building was avoided. The power building is 94 by 46 ft. with a 28-ft. ceiling. It is constructed of brick with simple stone trim and steel sash, ample provision being made for natural light and ventilation. Artificial lighting is provided through fifteen 200-w. lamps suspended from the ceiling. The side walls are to be enameled white. The floor is of cement with all cables and piping placed in 3-ft. deep trenches, which are covered with removable iron plates, making such cables and pipes readily accessible. A 5-t., 30-ft. lift, hand-operated traveling crane with double I beams, built by Crane & Hoist Corp., spans the engine room to provide for inspection and repair of heavy parts.

Auxiliaries Installed in Basement

Auxiliary apparatus such as pumps, tanks for cleaning and recharging the air filter units and oil tanks, are located in the basement. Exhaust and intake pipes are run underground to the exterior of the building, the air filters being accessible from the basement. All pipe trenches also open directly into the basement, thus making inspection and repairs more convenient.

Two of the power units now installed are 4-cylinder, 2-cycle, solid injection Fairbanks-Morse Co. Diesel engines, direct connected to 375-kw., 3-phase, 60-cycle, 2400-v., alternators of the same make, operating at 257 r.p.m., 113 amp. per terminal and 0.8 power factor. Each is direct connected to a 15-kw., shunt-wound exciter.

The third unit is a 4-cylinder, 2-cycle, solid-injection Fairbanks-Morse Co. Diesel engine direct connected to a 240-kw., 3-phase, 60-cycle, 2400-v., alternator of the same make operating at 257 r.p.m., 72.2 amp. per terminal and 0.8 power factor. A 10-kw., shunt-wound exciter is direct connected on the shaft. All exciters are overhung from the outboard bearings of their respective generators.

Remote Control

Each engine is controlled at the switchboard. When an idle engine is to be put under load, it is first started independently, then the voltage of its generator is raised to correspond with the bus-bar voltage by reference to the two voltmeters and the incoming engine is adjusted to synchronous speed and proper phase by referring to the synchronoscope. The load is divided, or transferred from one engine to another, by varying the speed of either engine depending upon how the pointer varies from 60 on the frequency meter. If more than 60 is registered, the speed of the engine originally under load should be reduced; if less than 60, the speed of the incoming engine should be increased. To divide the load between two units, the exciter voltages must be the same before the transfer switch on the regulator of the engine that is to remain on the line is thrown in and the engine comes under the control of the automatic voltage regulator because the generators are nonparallel excited. In taking an engine off the line, its load is reduced to aproximately zero, then the circuit breaker of that machine is opened.

All-Steel Unit Type Switchboard

Switchboard, of the unit-panel steel type, was furnished by the Westinghouse Electric & Manufacturing

Co. Each generator and each feeder line has an individual panel, all being shipped to the plant completely furnished with the necessary instruments. Bus bars and circuit breakers were mounted after the board was installed. Each panel is constructed with channel-shaped sides which not only stiffen the construction and provide for clamping with adjacent panels but also furnish protective and convenient means for placing the electrical leads. Means for connection clamps at any height of the board are also provided in these channels.

Disconnects, between bus bar and instrument transformer, are provided so that any panel can be quickly isolated, in case of trouble. Each feeder panel is furnished with the following instruments: an ammeter which, by means of a rotary switch, will indicate each of the three phases; a watt-hour meter with demand attachment, which shows the peak load on that feeder, and an overload trip with bell alarm. Each generator panel has a direct-current ammeter, an alternating-current indicating kilowatt meter, an alternating-current ammeter with a rotary switch and a watt-hour meter with demand attachment. Every panel is supplied with power-factor meter switch and oil circuit breaker. A double-throw switch is provided so that any one exciter may be used for any generator. A 3-phase, electrostatic indicating ground detector is mounted over the middle of the switchboard.

At the extreme left, a General Electric Co. automatic voltage regulator is installed and above this, on a swinging bracket, the following meters are mounted: a synchronoscope with lamp indicator, a direct-current voltmeter for the exciter, an alternating-current voltmeter for the generator, an alternating-current voltmeter for the bus bars, a power-factor indicating meter and a frequency meter. With the exception of the voltage regulator, all instruments on the switchboard are of Westinghouse make.

Provision is made for a totalizing meter, recording all current used in the plant, with a master switch controlling this circuit and a demand attachment for showing the peak load for plant consumption. All circuit breakers have bell alarms.

Value of installing a ground detector is shown by the fact that, when the detector was connected into the distribution circuit, it showed at once a 6.2-amp. loss on one grounded phase of a 2300-v. circuit.

Trouble Shooting Made Easy

Trouble may be located on the switchboard in three minutes time. First the panels are isolated, one at a time, until the ground detector shows clear. Then the ground detector shows the phase and strength of ground on the circuit in which the ground has occurred. The lineman is then notified of the feeder circuit and phase in which the ground is indicated. Each branch or tap off of a feeder circuit has a fused sectionalizing switch, which the lineman can open up individually until the ground is located. In this way, a ground can be located and cleared in from ½ to 4 hr. time.

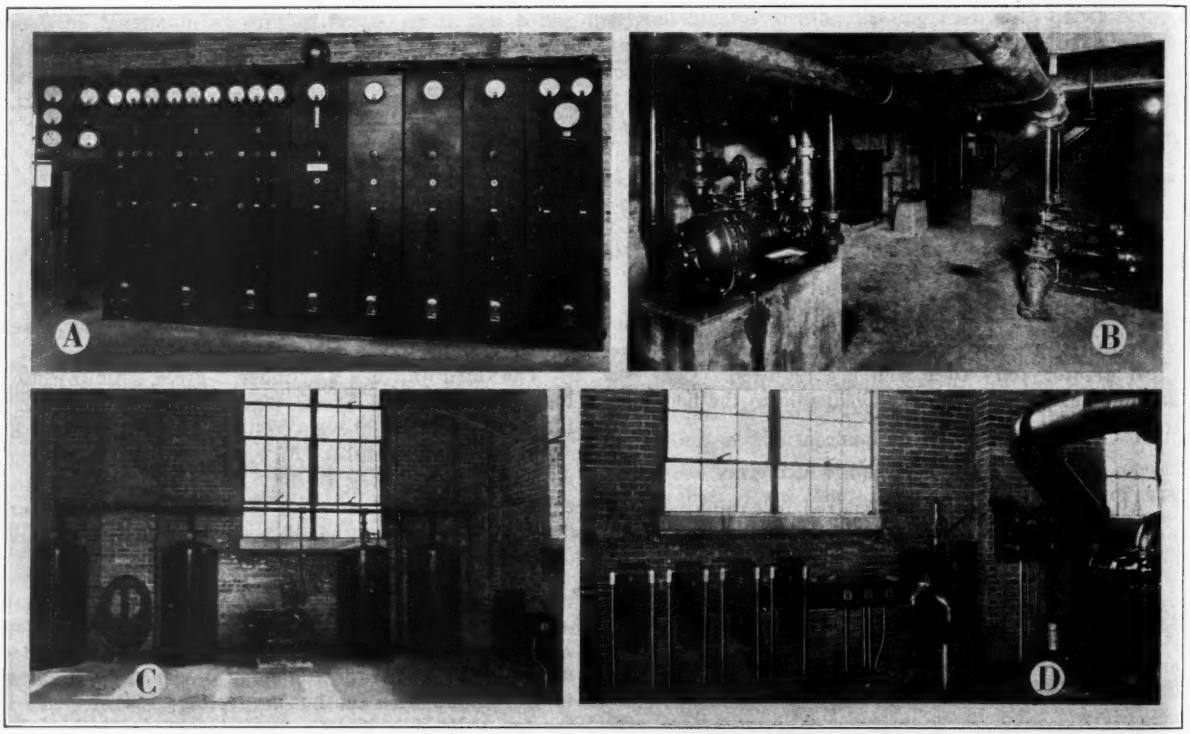

FIG. 4. INTERIOR VIEWS OF PLANT EQUIPMENT: A. SWITCHBOARD; B. AUXILIARIES IN BASEMENT; C. AIR STARTING EQUIPMENT; D. CENTRIFUGE, OIL HEATER AND EXHAUST PYROMETER INDICATORS

Distribution System Looped for Convenience

Spread out over an area 6 mi. long and 2½ mi. wide, the distribution system is divided into four different feeder circuits for town service and two for street lighting. These may be divided into loops in order to facilitate location and rectification of trouble. An aux-

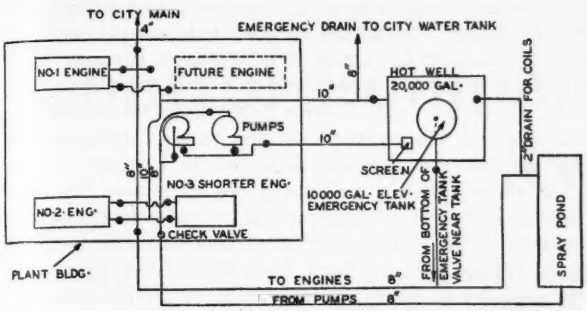

FIG. 5. DIAGRAM OF COOLING WATER PIPING CONNECTIONS BETWEEN ENGINES, PUMPS, COOLING COILS AND HOT WELL

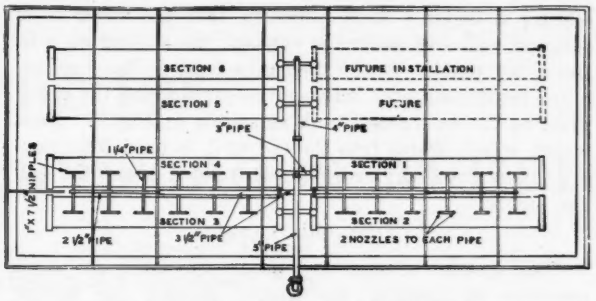

FIG. 6. SPRAY POND FOR COOLING ENGINE CYLINDER JACKET WATER

iliary switch on each panel provides a means for determining at once whether the location of a break in the line is in the plant or in the distribution system.

City water storage is provided in a 200,000-gal. steel tank, elevated 150 ft., thus giving an approximate water pressure of 65 lb. A 4-in. emergency line connects the city main to the cooling water system for the engines and a steel storage tank for 10,000-gal. water, elevated about 35 ft. is provided for emergency should the water pump fail, in order to provide sufficient time to change from the closed cooling water system to the city main. Sufficient water is thus supplied to run the plant 15 minutes. Water connections are indicated in Fig. 5.

Water Cooling System

Engine jacket cooling is accomplished by a closed system, the cooling water being circulated in a spray pond through a large number of 1-in. dia. aluminum tubes, 20 ft. long, arranged in six sections with headers at each end as shown in Fig. 6. The sections are placed above the level of the water in the spray basin and sprayed from above by 52 1-in. Marley spray nozzles operating under a pressure of about 7 lb. The cooling system is sufficient for the present plant operating under full load but space is provided for adding sufficiently to the cooling system to provide for 2200-hp. engine capacity without necessity of rebuilding the system. Louvers are provided on all sides of the pond to confine the spray. A 250-w. lamp is reflected upon the spray pond for flood lighting.

Water coming from the engine jackets discharges into a 20,000-gal. hot well constructed of concrete set in the ground and level with it. Circulating water pumps, installed for emergency in duplicate, each being of the Fairbanks-Morse centrifugal type having a capacity of

COMPANY Hobart Light and Water Co.
LOCATION Hobart, Ind.
THIS LOG SHEET IS TO BE RETAINED BY LOCAL OFFICE

DAILY GENERATING REPORT

FOR THE 24-HOUR PERIOD OF 2-5 1930 ENDING AT MIDNIGHT

TIME	Gen. No. 1 Meter Reading	Gen. No. 1 KWH	Gen. No. 1 Ind KW	Gen. No. 1 Exh Temp	Gen. No. 1 Oil Temp	Gen. No. 2 Meter Reading	Gen. No. 2 KWH	Gen. No. 2 Ind KW	Gen. No. 2 Exh Temp	Gen. No. 2 Oil Temp	Gen. No. 3 Meter Reading	Gen. No. 3 KWH	Gen. No. 3 Ind KW	Gen. No. 3 Exh Temp	Gen. No. 3 Oil Temp	Gen. No. 4 Meter Reading	Gen. No. 4 KWH	Gen. No. 4 Ind KW	Gen. No. 4 Exh Temp	Gen. No. 4 Oil Temp	Station Output	Frequency	Station Use Meter Reading	Station Use KW	Misc Plant Meter Reading	Misc Plant KW	Water Inlet	Water Outlet 1	Water Outlet 2	Water Outlet 3	Water Outlet 4
Midn.	52800					55550					95800	150	150	300							150	60	13500				75				
1 a.m.											95950	150	140	280							150	60	13500				75				
2											96050	100	130	260							100	60	13500				70				
3											96200	150	130	260							150	60	13500				70				
4											96350	150	130	260							100	60	13560				70				
5											96450	100	130	280							150	60	13560				70				
6											96600	200	200	320							200	60	13620				70				
7																					100	60	13620				70				
8						55650	100	250	340	105											200	60	13620				70				
9						55950	300	260	340	115											250	60	13620				70				
10						56200	250	280	360	120											300	60	13680				70				
11						56500	300	270	380	120											300	60	13680				70				
Noon						56800	300	250	360	120											200	60	13680				70				
1 p.m.						57000	200	250	340	120											300	60	13740				70				
2						57300	300	260	340	120											300	60	13740				70				
3						57600	300	270	380	125											350	60½	13800				70				
4						57950	350	300	380	125											400	60	13800				70				
5						58150	200	220	320	120	97000	200	140	260							450	60	13800				75				
6						58450	300	290	360	120	97150	150	150	280							400	60	13860				75				
7						58700	250	270	340	120	97300	150	150	280							300	60	13860				75				
8						59000	300	250	320	120	97400	100	140	260							350	61	13860				75				
9						59250	250	230	300	120	97500	100	130	260							250	60	13920				75				
10						59500	250	270	360	120											250	60	13920				75				
11						59750	250	210	300	120											200	60	13920				75				
Midn.											97700	200	150	300																	
Total						4200					1900												420								

Generator	Hrs. Oper.	KWH
Gen. 1		
Gen. 2	15	4200
Gen. 3	12	1900
Gen. 4		
Total	27	6100

Max. Peak Load 440 KW At 6 P.M.
Average Load 257 KW
Load Factor 26.3 %
Repairs Made and Remarks:

STREET LIGHTING RECORD
Circuit 6 On—P. M. 5:25 Off—A. M. 6:30 Reading on 2200 Reading off 2340 KWH 140

Supplies Used	Storage	Received	Used	Balance	Unit	Total Cost
Lubricating Oil						
Fuel Oil			3			
Waste						
Miscellaneous						
Labor (Regular)						
Labor (Extra)						
Total						

INTERRUPTIONS

Circuit	Time Off	Time On	Cause
		None	

Operator John Kibler — Time on 12 M — Time off 8 A.M. — Ground Detector Clear
Operator E. M. Green — Time on 8 A.M. — Time off 4 P.M. — Ground Detector Clear
Operator Fred Kizziferin — Time on 4 P.M. — Time off 12 P.M. — Ground Detector Clear
Chief Operator W. J. Achee — Time on 9 A.M. — Time off 4 P.M. — Ground Detector Clear

Note: Each operator must sign this report showing the hours of his shift. Interruption information called for must be shown. If none, so state. Mark ground detector clear or grounded.

FIG. 7. DAILY GENERATING REPORT SHEET

400 g.p.m. against 35-lb. pressure, take the water from this hot well and deliver it through the cooling coils in the spray pond. Water then goes back to the engines, a line being connected between the engines and the spray pond to the emergency tank as shown in Fig. 6. Rain water, which drains into the hot well, is used for make-up, the amount required at present being about 150 gal. per month.

Fuel Oil System

Two grades of fuel are used. In order to avoid necessity of heating the supply during the winter

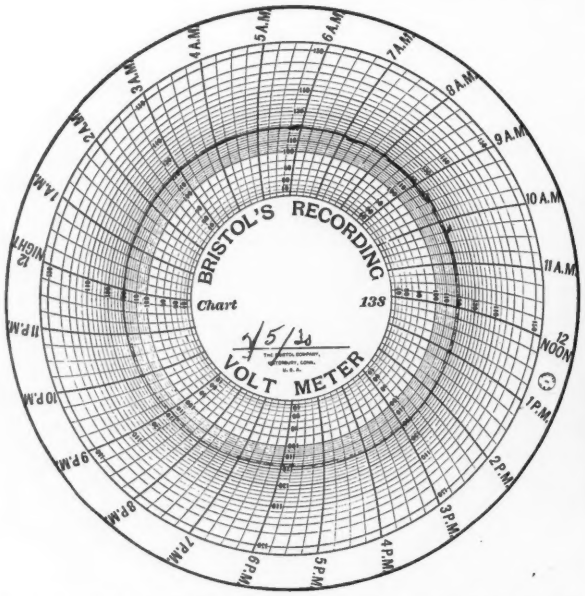

FIG. 8. VOLTMETER CHART SHOWING STEADINESS OF OPERATION

months 30 to 32 Baumé gravity oil is used while during the warmer months 26 to 28 Baumé oil which has a heating value of 18,750 B.t.u. per lb. is used. Fuel comes to the plant in tank cars on a railroad siding about 50 ft. from the two 10,000-gal. steel storage tanks which are set on concrete piers above the ground level. Below these piers and set in concrete about 1 ft. below the ground level, are individual steel day tanks for each engine.

Unloading is accomplished by a 3-hp., motor-driven Viking rotary pump which forces the oil to the storage tanks whence it flows by gravity into the day tanks as required. A fuel pump attached to each engine pumps the oil from the respective day tank to its engine, a bypass returning such as is not required, according to the load on the engine.

Filters Remove Grit from Air

Air for scavenging and combustion is brought in through stacks 12 ft. high with protected tops and then through Midwest multicellular air filters, each engine having its own filter. All air filters are interchangeable and a complete set of spare filter cells are provided to facilitate cleaning and recharging, which is done in a dipping vat located in the basement.

Exhaust is cooled by water-jacketed manifolds, the exhaust piping from each engine passing to an individual exhaust pit located underground just outside of the building. Connected to each exhaust pit and installed immediately above it is a Maxim silencer from which the exhaust passes through a stack which extends 3 ft. above the roof. Brown pyrometers for indicating the exhaust temperatures of the various cylinders of the engines are provided as shown in Fig. 4D.

Standard Oil Co. medium Diesel oil is used for both piston cooling and lubrication of cylinder and machine bearings. The lubricating oil drains from the engines to a 200-gal. settling tank from which it is drawn by the transfer oil pump. Reclamation of the oil is accomplished periodically in a size 4A Sharples centrifuge which is driven by a Westinghouse alternating-current motor. Before passing through the centrifuge, the oil is heated by a Westinghouse 6000-watt electric heater which has, in order to prevent overheating, a red pilot light connected in the circuit as shown in Fig. 4D,

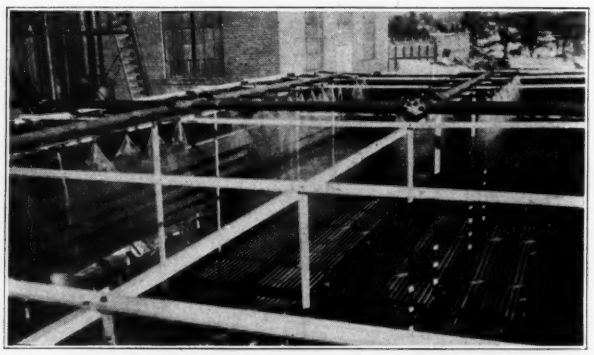

FIG. 9. SPRAY POND IN ACTION

thus informing the operator when the heater is in operation so that it will operate only when the centrifuge is running. A horn alarm, also shown, is provided to indicate when pressures are too low or high. The limits allowed for the cooling water system are 10 to 30 lb. and for the lubricating oil system, 18 to 30 lb.

Scavenging air is served to the cylinders at a pressure of from 2 to 3 lb., starting air, at 250 lb. from four steel tanks. For the latter, two 3¾ by 3⅜-in., Fairbanks-Morse air compressors running at 475 r.p.m., are provided. The one usually used is driven through a short belt drive by a 3-hp. Fairbanks-Morse motor; the duplicate unit, which is for emergency use, is direct connected to a 3-hp. Fairbanks-Morse gasoline engine.

Complete Records Kept and Analyzed

Besides thorough appointment as to equipment, this plant is characterized by excellent record keeping and analysis. Hourly readings are made as indicated on the daily report sheet shown in Fig. 7. From these daily reports, similar monthly reports are compiled and it is expected that these reports will be the bases of yearly reports.

Under present light-load operation, 10.85 kw-hr. per gal. of fuel is generated by the 360-hp. unit while the corresponding figure for the 560-hp. units is 10.5 kw-hr. For lubricating oil, 3360 kw-hr. per gal. are obtained from the 360-hp. unit while 2700 kw-hr. per gal. are obtained from the 560-hp. units.

Burns & McDonnell of Kansas City, Mo., were the consulting engineers. H. W. Finch is manager of the operating company and H. J. Achee, chief engineer.

Control Equipment for Synchronous Motors

Part II. General Types of Synchronous Motor Control Panels. Description of Equipments, Sequence of Operation and General Application.

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Ideal Electric & Mfg. Co.

HAVING PRESENTED briefly the fundamentals of the synchronous motor and having stated the requirements of synchronous motor control, we will now describe the general types of synchronous motor control panels.

In general, there are six quite distinct types of control panels. These types are basic, depending upon the manner in which the control functions. Practically every kind of synchronous motor control, whether standard or special, falls into one of the following general classifications.

(1) Manually operated, full voltage starting.
(2) Manually operated, reduced voltage starting.
(3) Semi-automatic, full voltage starting.
(4) Semi-automatic, reduced voltage starting.
(5) Full-automatic, full voltage starting.
(6) Full-automatic, reduced voltage starting.

The first three of these will be described in this article and the last three in the succeeding article.

In connection with the following discussion of the equipment furnished and features incorporated in the various methods of control, it should be noted that an attempt will not be made to cover all specific features in detail but simply to explain characteristic types and the functions of each. The reader will then become primarily acquainted with the fundamentals of synchronous motor control apparatus. As a means of summarizing the reasons for the various types of control apparatus, a discussion dealing with the factors governing the selection of control for different applications will follow the control explanation.

It should be mentioned that the equipment supplied by various manufacturers for applications of the same nature often differs somewhat as to specific details but, in general, the apparatus is covered by the following general specifications.

(1) Manually Operated, Full Voltage Starting Panels

Usually a standard synchronous motor starter of this type will consist of the following apparatus, mounted on a panel board of slate, ebony asbestos or other suitable material:

(a) Hand operated main line switch.
(b) Hand operated field switch, with clip for field discharge resistance.
(c) A.c. ammeter.
(d) D.c. ammeter.
(e) Pilot light for indicating d.c. voltage.
(f) Two current transformers for overloads and a.c. ammeter.
(g) One potential transformer (above 550 v.).
(h) Motor field discharge resistor.

Main line switches should be oil immersed, direct or remote mounted, depending on requirements, as overload protection and no voltage release are usually incorporated in such switches. On all types of control panels, mounting must be provided for a motor field discharge resistor. The resistor itself is furnished with the synchronous motor as standard equipment regardless of whether or not the motor manufacturer supplies the starting panel.

Sequence of Operation

The sequence of operation for a manually operated full voltage starting panel is quite simple and yet requires a somewhat experienced operator in order to prevent damage to the motor and to minimize line disturbances. The main line switch is thrown in. When the motor comes up nearly to synchronous speed, the operator throws in the field switch applying d.c. excitation to the rotor, causing the motor to pull into step and synchronize with the line. If the field switch is thrown in too soon, the motor may slow down and stop or if it finally does synchronize, the line disturbance will be excessive. Much depends upon the operator in determining when the field switch should be thrown in. Some operators depend upon the sound of the motor as it approaches synchronous speed. If a belted exciter is used, the building up of exciter voltage as shown by the pilot light provides a good indication of speed, the light becoming bright as the motor and exciter approach normal speeds. Usually the operator can become sufficiently familiar with the timing of his procedure after a few starts.

General Application

Manually operated full voltage control panels embody the minimum equipment and are, of course, the most economical from the standpoint of initial cost; however, since the introduction of automatic control, these types of starters are rather infrequently used. As full voltage starters are ordinarily used only on slow

speed synchronous motors, hand operated starters will usually compete only in connection with relatively small horsepower motors. On installations of appreciable size, 100 hp. or larger, the initial cost of the motor alone is usually sufficient to warrant the extra expense for an automatic starter.

(2) Manually Operated, Reduced Voltage Starting Panels

Equipment supplied in this case may be the same as that for the manually operated full voltage starter except for the main line switch and the addition of a

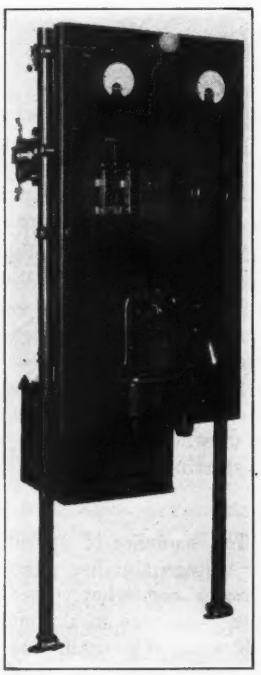


FIG. 1. MANUALLY OPERATED REDUCED VOLTAGE STARTING PANEL

FIG. 2. MANUALLY OPERATED REDUCED VOLTAGE STARTER (WESTINGHOUSE ELEC. & MFG. CO.)

means of obtaining reduced voltage. The main line switch may be a standard compensator with start and run contacts or in the case of larger motors separate oil immersed switches, together with an auto transformer or other source for obtaining reduced voltage may be used.

Sequence of Operation

The sequence of operation is the same as for the manually operated full voltage starter except for main line switch operation. When starting the synchronous motor the operator throws in the starting switch and holds it in, until the motor has reached approximately 80 per cent of synchronous speed. The starting switch is then released and the running switch thrown in, in quick succession. The switches are usually interlocked so that the starting switch must be operated before the running switch. The starting switch ordinarily cannot be left closed as it opens when its handle is released by the operator. An exception to this is the special case of closed transition where the starting switch is not opened until after the running switch has closed. This is sometimes done where minimum line disturbance is desirable.

General Application

Reduced voltage starting is used, particularly on medium and high speed synchronous motors from 514 r.p.m. up, where the inrush current drawn from the line at starting is in excess of power companies' requirements. It is also used where motors are located on the end of long feeder lines where full voltage starting would cause excessive line voltage drop; or where motors are starting against a relatively small generating capacity, as would be the case in small power plants.

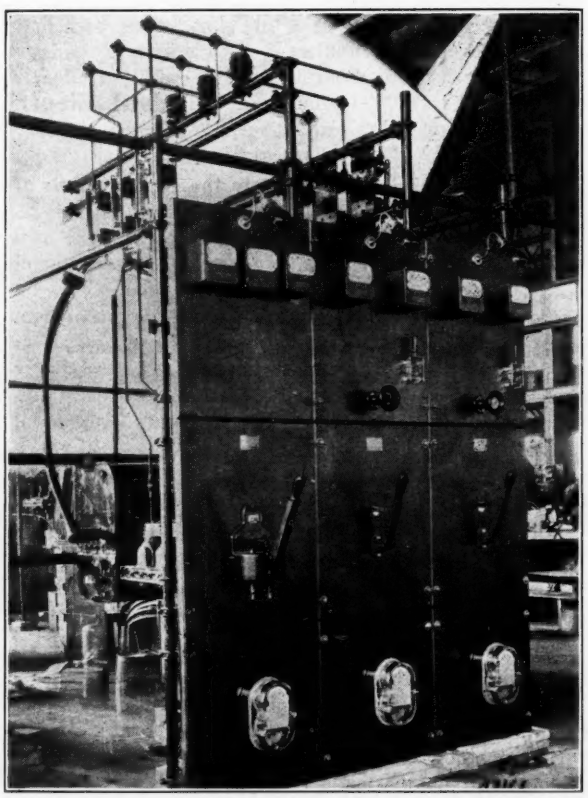


FIG. 3. THREE-PANEL SWITCHBOARD

Figure 1 shows an Ideal manually operated reduced voltage starting panel. At the top of the panel are the a.c. and d.c. ammeters; immediately below the rheostat handle and field switch; and at the bottom the starting and running handles for operating the oil immersed contactors mounted back of the panel.

This illustration is also typical of the manually operated full voltage starter previously described, the only difference being that one main switch operating lever would be seen instead of two on the front of the board.

Figure 2 shows another make of manually operated reduced voltage starter, this being that of the Westinghouse Electric & Manufacturing Co. The panel design and equipment furnished is essentially the same in each case.

Figure 3 is an interesting illustration of a 3-panel manually operated reduced voltage switchboard, and includes an incoming panel together with two starting panels for a 60-hp. and a 100-hp., 2200-v. motor respectively. As indicated by the apparatus purchased, the user in this case was interested in low initial expenditure, but at the same time, wished to obtain an accurate check upon the operation of his plant. The incoming panel on the left is provided with a totalizing ammeter, a power factor meter, a kilowatt meter, a kilowatt-hour meter, and an incoming circuit breaker. Each motor starting panel, in addition to standard equipment, has

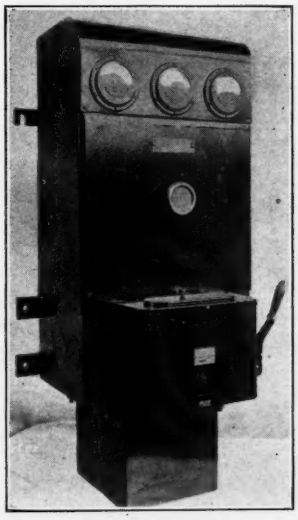


FIG. 4. SEMI-AUTOMATIC FULL VOLTAGE STARTER

a kilowatt-hour meter. A careful study of the records obtained from these instruments would certainly provide a plant manager with a thorough analysis of his power consumption. This illustration should not be considered as a recommendation for standard practice. It simply indicates what results may be obtained when desirable. So much depends upon power cost, type of plant, operating conditions, etc., that the selection of extra equipment should be accompanied by a definite analysis of each individual case, rather than selected on the basis of any general recommendation.

(3) Semi-Automatic Full Voltage Starting Panels

This type of control, as the term semi-automatic implies, approaches automatic control, yet retains much of the simplicity and low initial cost of manually operated control.

The equipment, in this case, will usually consist of the following, as a minimum:

(a) Hand operated main line switch.
(b) Automatic field switch.
(c) A.c. ammeter.
(d) D.c. ammeter.
(e) Pilot light for indicating d.c. voltage.
(f) Two current transformers.
(g) Potential transformer, above 550 v.
(h) Motor field discharge resistor.

As mentioned in connection with the manually operated full voltage starter, the main line switch should be oil immersed. Overload protection and no voltage release are incorporated as usual.

Automatic Field Switch Control

The main point of distinction in regard to the semi-automatic starter is the automatic field switch. The application of direct current excitation to the synchronous motor field has a definite relation to the speed of the motor. There is a point on the speed torque curve of every synchronous motor where the application of field excitation will enable the motor to synchronize with the line. This point is generally conceded to be at approximately 95 per cent of synchronous speed for conventional well designed synchronous motors. The operation of the relay or relays governing the closing of the field switch, then, must have a definite relation to the speed of the motor. There are several different

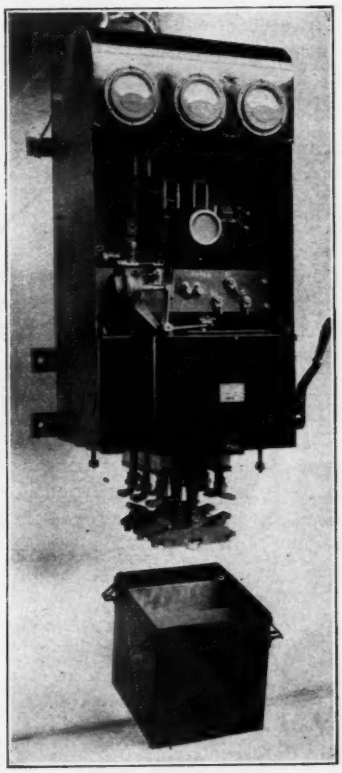


FIG. 5. SAME STARTER SHOWN IN FIG. 4 (COVER REMOVED)

methods by which the field switch operation is controlled.

One manufacturer uses a field control relay which depends upon the frequency of the induced current in the field circuit for its operation.

Another manufacturer employs a control consisting of two relays acting in opposition, one relay energized by induced current of motor field, the other energized from d.c. field excitation circuit.

A third manufacturer uses a control consisting of a relay energized by the voltage across the field discharge resistor (which in in series with the motor field during starting) and in addition a time relay. The time relay ensures that the motor will be accelerated to the maximum possible speed before field excitation is applied.

Still a fourth manufacturer employs a control consisting of a current limit relay, depending upon the inrush current in the stator for its operation and in addition a time relay.

These methods of control differ as to the energizing sources for the relays but perform essentially the same operation in providing a satisfactory means of closing the field switch at the proper time.

Sequence of Operation

The sequence of operation for the semi-automatic full voltage starting panel is quite simple. The operator throws in the main line switch and the rest of the sequence is automatic. The motor accelerates towards synchronous speed and as it reaches approximately 95 per cent of full speed, the relays start to function, energizing the magnetic field switch and closing it to place d.c. excitation in the rotor field poles, thus synchronizing the motor with the line.

General Application

The semi-automatic full voltage starter may be used for any standard synchronous application where full voltage starting is permissible. The addition of the automatic field switch makes this type of starter somewhat more expensive than the manually operated starter; but in many cases this expense is warranted. The operator is relieved of all responsibility except for the closing of the main line switch. This is a desirable feature because the motor is relieved from unnecessary starting strains and the transmission system is not subject to such severe jolts as is likely to be the case with full manual operation.

Figure 4 shows one type of semi-automatic full voltage starter. With all parts totally enclosed and with flush type meters set into the case, this starter is very compact, yet quite complete. It may be made wall mounted or supported on pipe or angle iron framework. Figure 5 shows the same starter with cover plates removed. Below is the main line oil immersed switch. Overload and no voltage protection are provided. On the bakelite panel, an air dashpot is mounted, which provides an accurate time adjustment for controlling the automatic closing of the field switch. The same equipment can, of course, be mounted unenclosed upon a standard panel section.

Semi-automatic, reduced voltage starting; full automatic, full voltage starting and full automatic, reduced voltage starting equipment will be treated in the next article of this series.

New orders of fabricated structural steel in January, 1930, as reported to the Department of Commerce by the principal manufacturers, were 68 per cent of capacity, based on total orders of 196,363 t. reported by fabricators with a capacity of 290,145 t. per month, as compared with orders of 83 per cent of capacity in December, 1929, and 71 per cent a year ago. Shipments of fabricated-structural steel in January represented 67 per cent of the capacity of firms reporting this item as against 72 per cent in December, 1929, and 73 per cent a year ago.

Conference on Better Coal Use

Sponsored by the Engineering Extension Department of Purdue University, the Coal Trade Association of Indiana and the Illinois Coal Bureau, in collaboration with the Fuels Division of the American Society of Mechanical Engineers, a three-day educational coal conference is to be held at Purdue University, Lafayette, Indiana, April 9-10-11.

It is planned as the beginning of a series of annual meetings, alternating between Purdue University and the University of Illinois, to determine newer means and better methods by which Illinois and Indiana coals may have wider application and midwest consumers a more economical fuel.

From a broad economic standpoint, it is more appropriate and intelligent to use the less expensive nearby coals, as nearly as may be exclusively, if a direct economy can be accomplished and other conditions satisfactorily met.

Accordingly, one of the main sessions, Thursday morning, April 10, will be devoted to a discussion of mechanical devices for burning Illinois and Indiana coal for domestic and semi-industrial application. It will be opened by T. A. Marsh of the Combustion Engineering Corporation's Chicago office, followed by representatives of household and small commercial and industrial stoker manufacturing companies.

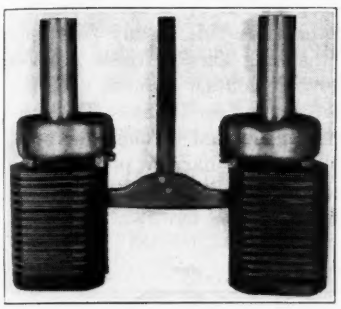
Immediately following this stoker session, the afternoon will be dedicated to retailers, with papers by Milton E. Robinson, Jr., Chicago, President of the National Retail Coal Merchants Association, whose subject will be Coöperation Between Organized Producers and Retailers and B. R. Gebhart, Public Relations Counsel, Illinois Coal Bureau, Chicago, subject, The Dealer as Fuel Counselor in His Community.

Friday morning, the main topic will be Reconditioning of Existing Plants to Burn Indiana and Illinois Coals Economically and Smokelessly, with Frank A. Chambers, Chief Smoke Inspector of the city of Chicago, John Hunter, Consulting Engineer for the city of New York and A. C. Willard, Head of the Department of Mechanical Engineering at the University of Illinois on the program.

Dean A. A. Potter will welcome the conference Wednesday afternoon, April 9, and two main subjects are prescribed for this session, Economic Justification for Greater Use of Illinois and Indiana Coals in the Middle West; and Availability, Classification and Suitability of Indiana and Illinois Coals for Various Uses. Speakers will be Alex D. Bailey, Chairman, Engineering Division, National Electric Light Association and Chief of Generating Stations for the Commonwealth Edison Co. of Chicago, W. D. Langtry, President, Commercial Testing and Engineering Co., Chicago, and Professor C. H. B. Hotchkiss of the Mechanical Engineering Department, Purdue University.

In reading gages calibrated in pounds per square inch when liquids other than water are being handled, it is necessary to divide the reading in pounds by the specific gravity and multiply by 2.31. Thus, with water a pressure of 100 lb. would be a head of 231 ft. with a brine of 1.25 s.g. the head would be only 185 ft. while, with oil of 0.85 s.g., the head would be 275 ft.

Using Gas For Arc Rupture *in* Circuit Breakers



Deion grid based upon theory that gas is effective in deionizing the arc space, shows unusual performance in both the laboratory and in the field.

IN THE PRECEDING article[1] covering this investigation of arc rupture, we presented Dr. Slepian's theory of arc rupture in oil and showed how, by means of porous plates extending into the immediate vicinity of the arc, the performance of a circuit breaker was greatly improved. In this present article, will be shown how this theory of arc rupture was built into a commercially feasible oil circuit breaker. This was the substance of a paper presented by B. P. Baker and H. M. Wilcox, both of the Westinghouse Electric & Mfg. Co., at the winter meeting of the American Institute of Electrical Engineers in New York.

It was realized that, in order to bring about the rapid formation of gas to serve as a deionizing agent, it was necessary to bring the air in direct contact with the oil as intimately as possible. For the space of time required to extinguish an a.c. arc, the body of oil in the breaker chamber is relatively immobile. The arc itself, however, has a rather high mobility. Consideration of these facts led to the conclusion that the logical course was not to move oil against the arc, an immobile body against a mobile one, but to move the arc against the oil, utilizing the natural mobility of the one and the immobility of the other to hold them in intimate contact. It was realized, however, that if the degree of immobility of the oil could be increased, for instance, held on or adjacent to surfaces from which it could not escape except to be given off into the arc stream, only moderate forces might be required to move the arc toward the entrapped oil and thus secure intimate contact between the arc and oil.

With this object in view, there has been developed for use in conventional oil circuit breakers, a device which at the present time has shown marked improvement in the rupturing performance of such breakers. This is the deion-grid, utilizing the idea presented in the preceding article.

Construction and Operation

Except for the details in the vicinity of the contacts, breakers now made with this device are the same in all respects as the standard breakers which have been supplied for service for a number of years. As the application of the new device broadens, it is quite possible that modifications in the design of other details of the breaker may be found desirable in order to secure full benefit from the improved rupturing performance and arc control, but, for the present, these details remain unchanged insuring the application of the device to breakers now in service.

Figure 1 shows the contact arrangement inside the chamber of a single-pole breaker unit. The conventional condenser terminal leads, each with a stationary contact element at its lower end, and the bridging, movable contact element constitute the conducting current loop while the interrupting elements in which the two arcs are drawn, are supported, one from each stationary contact. The current-carrying contacts are of the plain-break butt-contact type, the movable member being of rigid but light construction well adapted to rapid acceleration for fast opening speed. The stationary contacts are equipped with the conventional bells or static shields common to circuit breakers for high-voltage service.

The interrupting element or stack of grid plates from which it has derived its name is shown in Fig. 2,

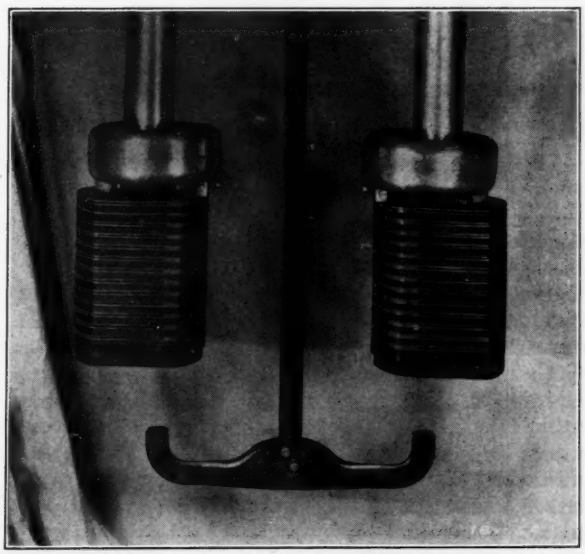


FIG. 1. INSIDE VIEW OF THE OIL CIRCUIT BREAKER EQUIPPED WITH DEION GRIDS

[1]March 1 issue, page 282.

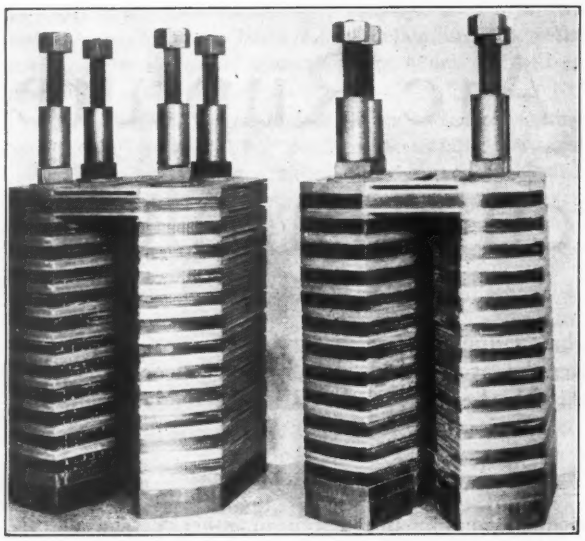


FIG. 2. THE ARC EXTINGUISHING STRUCTURES, I.E., THE DEION-GRID, READY FOR MOUNTING IN AN OIL CIRCUIT BREAKER

one of these grids being supported from each stationary contact element as shown in Fig. 1. The particular grid shown here is designed for 110-kv. service and is made up of eleven similar units such as are shown in Fig. 3, each unit in turn being made up of plate elements of insulating and magnetic material. Each individual grid plate carries a slotted opening, the purpose of which will be explained later, and four holes so arranged that when the several units are stacked up in the completed grid, insulated studs can be passed through for the purpose of clamping the units firmly together and for supporting it from the stationary contact element. The bottom plate or lowermost unit of the stock as shown in Fig. 4, is a single plate of insulating material serving as an anchorage for the clamping studs as well as a guide to insure accurate entry of the movable contact element into the grid during the closing contact movement.

As shown in Figs. 2 and 3, the slotted openings in each individual plate element all register in the completed grid to form a single deep and relatively narrow groove, extending throughout its length. This groove is closed at one end of the grid but open for its entire length at the other end, the two grids in any pole unit being arranged so that the long axes of these grooves lie in the plane of the movable contact element with the open end of the two grooves facing each other. The ends of the movable contact element extend through the open ends of the grooves well into the narrow portion, one end of the contact in each grid. As the contacts part on opening, the movable element passes downward through

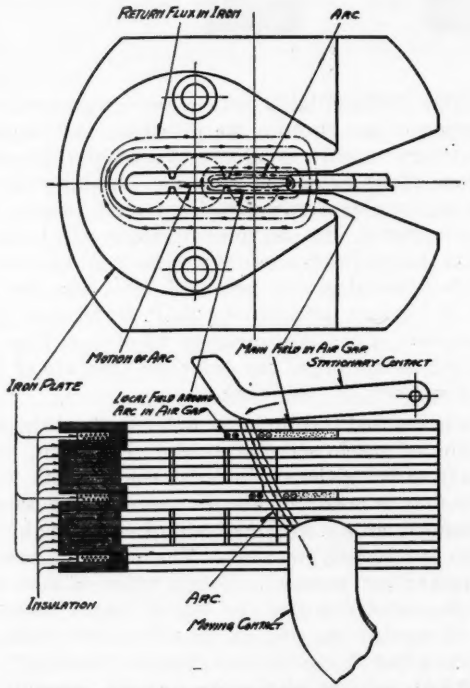


FIG. 4. SCHEMATIC RELATIONSHIP OF THE ARC AND ELEMENTS OF THE GRID STRUCTURE, SHOWING THE MANNER IN WHICH THE DRIVING FORCE ON THE ARC IS PRODUCED

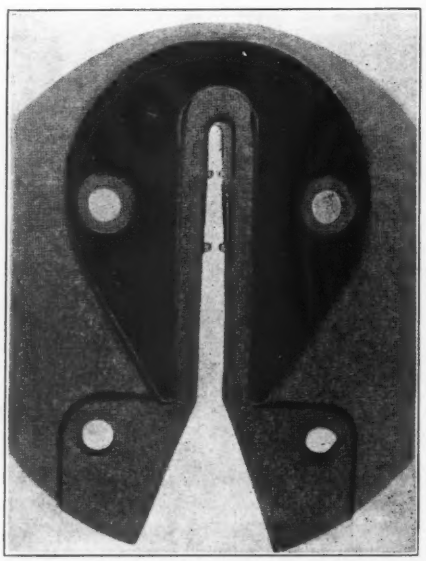


FIG. 3. AN ELEMENTAL GROUP OR UNIT OF WHICH THE DEION-GRIDS ARE MADE UP, SHOWING THE ARRANGEMENT OF THE IRON AND INSULATING MATERIALS

the groove and on to the end of the stroke, well out of the grids, leaving an ample space of clean oil between the contact surfaces and the bottom of the grid to insure adequate insulation in the open position of the breaker. The arc produced by parting of the contacts is then drawn and extinguished in this narrow groove, closed on all sides except for the opening at the inner end necessary to permit contact movement and the openings at the top and bottom of the grid.

The iron plate elements in the grid are inserted to produce a magnetic field for the purpose of moving the arc toward the closed end of the groove after it is drawn. As shown in Figs. 3 and 6, each individual iron plate is roughly horseshoe shaped, forming a partial magnetic circuit with an air-gap coresponding to the slotted opening in the insulating plate elements. As the contacts part when opening the breaker, an arc in drawn between the stationary and moving elements in the narrow groove of the grid. As the contact moves downward

toward the open position, the arc is drawn through the air-gap of the iron plate, giving rise to a magnetomotive force in the iron circuit and across the air-gap of one turn times the current in the arc. As the contact continues downward, the same effect is produced in the next succeeding iron plate and so on until the arc is extinguished. These magnetomotive forces are applied almost entirely across the air-gaps in the several grid plates, distorting and strengthening the magnetic field around the arc in such manner that the arc is moved toward the closed end of the magnetic circuit which is also the closed end of the groove.

Theory of Operation

From his study of the long a.c. arc as observed in the rupturing performance of the expulsion fuse, Slepian

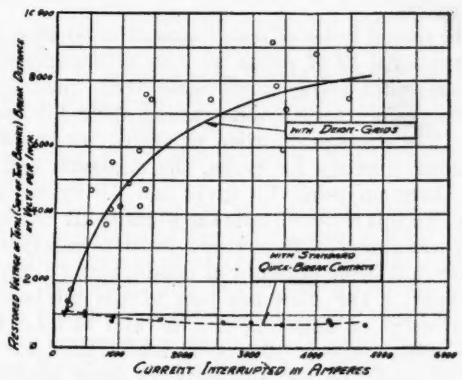


FIG. 5. RELATIONSHIP OF CURRENT INTERRUPTED TO RESTORED VOLTS, R.M.S. PER INCH OF BREAK DISTANCE IN AN OIL CIRCUIT BREAKER WHEN EQUIPPED WITH QUICK BREAK CONTACTS AND DEION GRIDS

has drawn the conclusion that in intense blast of gas passing through an arc greatly increases the rate at which the arc space recovers dielectric strength after the current zero and so greatly increases the volts per unit of length which may be interrupted by an arc in practical circuits. He concludes further that this increase in the rate of recovery of dielectric strength is derived largely from the increased diminution of ions in the conducting path through recombination, since the gas passing through the arc stream is in highly turbulent motion and, particularly at the current zero, supplies small volumes of fresh, relatively cool, un-ionized gas which, dispersed throughout the arc space, act as nuclei about which the recombination of ions takes place at a tremendously greater rate than would be possible in the hot gas of the arc stream alone.

It appears, then, that to be most effective in a.c. arc extinction, the oil circuit breaker must be capable of drawing and maintaining the arc continually in contact with fresh oil, that this contact between arc and oil must be sufficient to produce a high rate of decomposition of the oil, and the surroundings must be such as to force all of the gas and other products of oil decomposition to penetrate the arc stream, throughout its entire length.

It was in an endeavor to meet these requirements for most effective arc extinction, in other words to make more efficient use of the oil in arc rupture, that the deion grids described were developed. As stated previously, the aim was to utilize to better advantage the relative immobility of the oil and the extreme mobility of the long arc using the natural forces inherent in these two elements to secure the desired results.

From the description of its construction and operation given in earlier paragraphs, it will be noted that the arc is drawn between the parting contacts in a vertical, relatively narrow, deep groove formed by slots in the several plate elements of the grid and closed at the outer end. Plates of magnetic material, spaced at intervals throughout the grid and so arranged as to form a partial return circuit, provide a magnetic field when an arc is drawn through the air-gap which is a part of the groove. This magnetic field operates to move the arc steadily toward the closed end of the groove. Since the grid is submerged in oil, the groove is filled with oil which cannot escape except through the small openings at top and bottom and which for the short interval of time that the arc exists is for all practical purposes solidly entrapped. Furthermore, the groove is very nar-

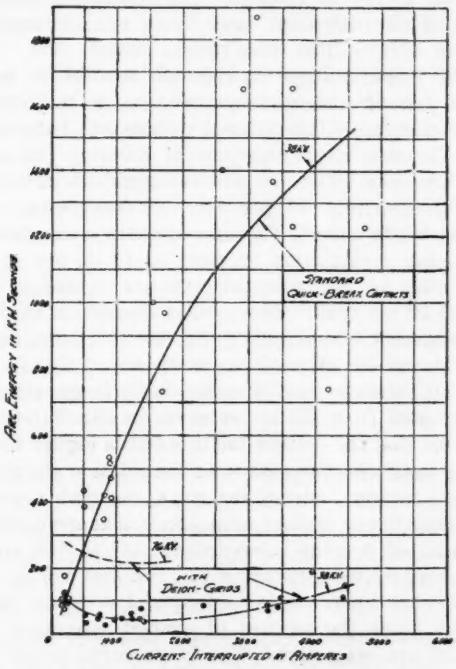


FIG. 6. RELATIONSHIP OF CURRENT INTERRUPTED TO ARC ENERGY IN AN OIL CIRCUIT BREAKER WHEN EQUIPPED WITH QUICK BREAK CONTACTS AND WITH DEION GRIDS

row and the arc, drawn longitudinally through it, fills practically the entire open end of the groove.

From this it will be apparent that an arc moving toward the closed end of the groove is in effect being forced against a solid wall of oil throughout its entire length, resulting in a high rate of decomposition of the oil with an accompanying continuous and adequate supply of fresh un-ionized gas. This gas cannot escape except through the arc stream since the arc fills the open end of the groove. Due to the driving power behind the arc, the gas is forced to pass through the arc stream, diluting it with small volumes of un-ionized gas, while current is flowing, which act as deionizing surfaces after the current zero is reached. An additional deionizing effect is obtained from the sides of the groove where the arc impinges as it moves. The insulating plate elements

in the grid are of absorbent material containing in their submerged condition considerable oil content. As the arc passes over the edges of these grid plates exposed in the sides of the groove, the heat forces this material to give off its oil which is also volatilized and thrown turbulently into the arc stream. This characteristic of giving off oil and creating a gas film along the edges of the plate elements also serves to protect them from burning under the heat of the arc. Large numbers of interrupting tests have been made with a single set of grids without appreciable burning.

Laboratory Tests

Power for development tests of the deion grids was supplied by two 20,000-kv-a. generators either direct-connected or feeding through a bank of three 33,333-kv-a. transformers. The tests on the grids shown in Figs. 1 and 2 were all made at 60 cycles with currents ranging from 20 amp. to 15,000 amp., and at voltages of from 13,200 to 176,000. The maximum energy for any test was the plant capacity of approximately one-quarter of a million kv-a. single phase.

The initial voltage on this test was 86 kv. across a single pair of contacts; however, due to the decrement of the generators the restored voltage was reduced to 77 kv. The current at the time of drawing the arc was 1200 amperes. The arc was extinguished in 2.5 cycles of approximately 30 per cent of the opening stroke, during which time 100 kw-sec. of energy was dissipated, producing a maximum pressure of 18 lb. per sq. in. as registered by the pressure indicator attached to the bottom of the tank. The contact separation at the time of extinction was only 5½ in., which is equivalent to 7000 v. per in. of total break distance (11 in.). This value of volts per inch is considerably larger than might be expected from the upper curve in Fig. 5, but it may be noted that the voltage for this test is higher than that of the tests used for obtaining the relation shown in the curve. Figure 5 shows the r.m.s. restored volts across the contacts per inch of total break distance plotted as a function of current interrupted; that is, the ordinates are obtained by measuring the restored voltage across the breaker upon arc extinction and dividing this voltage by twice the amount of contact separation at the time of arc extinction. The lower curve shows the results of tests using standard quick-break contacts. The upper curve shows the operation of the same breaker under the same test and circuit conditions, with a set of deion-grids as shown in Fig. 1.

Figure 6 shows the relation of arc energy to current interrupted for the quick-break contacts and for the grids in the preceding tests. The upper curve shows the arc energy in kw-seconds plotted as a function of current for the quick-break contacts, while the lower curve shows the same relation for the grids. The large arc energy and the scattering of the points in the upper curve illustrate the inefficiency and lack of control of the deionizing agencies inherent in the less effective use of oil hitherto obtained.

Field Tests

At the time this paper was prepared, the deion-grid had been subjected to field tests on only one operating system. These tests were divided into two series, both of which were made on a 66-kv., 60-cycle overhead transmission line, the maximum short circuit current available being approximately 7000 amp. A three-pole, 600-amp., 110-kv. electrically-operated oil circuit breaker already installed was equipped with grids and used for both series of tests.

The first series of tests involved 35 short circuit interruptions, 12 of which were on a three-phase basis, the remainder being single-phase line-to-line and line-to-ground. Current values for the three-phase tests ranged from 2500 to 5500 amp. and for the single-phase tests from 1000 to 7000 amp. The average duration of arcing for the 35 tests was approximately 1.8 cycles, which means that interruption was being obtained in less than one-quarter of full contact separation when opening at approximately 7.5 ft. per sec. (average lift rod speed). No oil was thrown on any of these tests, and no other disturbance was noted as an indication of heavy duty on the breaker.

The second series of tests consisted of 50 short circuit interruptions, 10 of which were on a three-phase basis, the remainder being single-phase tests line-to-ground. Current values for all tests ranged from 1000 to 3900 amp. The average duration of arcing for the 50 tests was approximately 1.9 cycles, the minimum and maximum duration being 1.0 cycle and 3.5 cycles, respectively. In this series of tests the average lift rod opening speed was about 7.7 ft. per sec., which means that interruption was being obtained at one-fourth of full contact separation. The dielectric test of the oil before the second series of tests was 21.6, 22, and 21.7 kv. for the three poles, while at the conclusion of the tests it was 21.6, 21, and 21.3 kv., the same oil being used for the complete series of tests. This shows a negligible decrease in dielectric for the three poles, and it is quite apparent that the breaker might have been subjected to a repetition of the complete series without the oil being deteriorated to the point of requiring renewal. The grids showed no indications of depreciation from the two series of tests beyond a trace of carbon lodged in the interstices of the grid plates and were in a condition to continue interrupting service without maintenance. No repairs or alterations were made in the grids at any time during the two series of tests.

Theoretically, the weight of air required for combustion can be calculated from the ultimate analysis of the fuel. This amounts to about 10.8 for coke, 11.7 for anthracite coal, 11.6 for bituminous coal, and 14.3 for oil. These are what may be considered average values of the pounds of air required to burn one pound of the fuel. The value will vary slightly with the exact ultimate analysis.

In practice, it is impossible to obtain perfect combustion with the theoretical amount of air and an excess amount which may in some cases amount to double the theoretical quantity is required. This depends upon the fuel, the method of burning and the furnace.

It is impossible to bring each molecule of the fuel into contact with oxygen, so that there is an unconsumed fuel loss that decreases as the excess air is increased. Excess air causes a loss due to heat carried up the stack, so that the best point of operation is determined by the point where the sum of the two losses is a minimum.

Securing Coöperation from the Plant Force

BONUS SYSTEM, CLEANLINESS AND TACT BRING EXCELLENT REWARDS IN DODGE CITY PLANT. BY W. J. NEAL

COOPERATION, the mainspring of success in any business, is especially necessary in engineering because of the responsibility for the safety of the men around the plant and the preservation of an expensive property. If some man fails to coöperate or obey orders, he may endanger lives and property—at the least he lowers the efficiency of the system for the time being.

In the Dodge City plant, we are striving for the maximum efficiency with the minimum expenditure; we are enjoying the coöperation from the general offices, the division manager and the local office, and the men at the plant. It is our aim to have a spirit of harmony among the workmen—every man is urged to feel that he is a spoke in the wheel of this particular industry and we strive to make each day a perfect revolution of this well-balanced wheel.

We work in 8-hr. shifts at the plant and, as this means that one-third of the men's time is spent there, we look after their comfort and well-being as much as possible. Washrooms and lockers are provided; a few chairs are placed throughout the building where a man may rest if he has spare moments. In order that a man reporting for duty may not find things at loose ends, he receives a report from the outgoing man; this enables him to begin his work well-informed and prevents waste of time.

EFFICIENCY CAMPAIGN REDUCES FUEL CONSUMPTION

At the present time, our plant is an efficient one but to prove that efficiency and coöperation are not the work of one man or the growth of a day, I shall go back to the years of 1922 and 1923. At that time the plant was remodeled with the purpose of producing a kilowatt on 3 lb. of coal. Prior to this time, we had burned 3½ to 4 lb. of coal per kw-hr. After the remodeling and installation of all kinds of instruments to assist us, our efficiency remained low, coal consumption high. The men in the plant regarded these instruments as ornaments, overlooking their real usefulness. The general manager and I, casting about for the root of the trouble, started a six months' efficiency campaign; the men who failed to attain the mark set for them were to be replaced by new men at the expiration of six months. At the same time, we instituted a bonus system which has remained in effect ever since. The campaign reduced our coal consumption from 4 lb. to 2½ lb. per kw-hr. in 30 days; it also fostered a competitive spirit among the men; every man on the plant force was eligible for the bonus list, getting his deserved percentage in reduction of coal consumed.

At the beginning of this efficiency campaign, we held meetings once a month to talk over the progress being made; we aroused interest in the new instruments. At the present time, our men depend upon them and guesswork is eliminated. Each man was allowed to express his opinion in these meetings and if he offered a practical suggestion it was put into practice. At the present time, we feel advanced enough that we have discontinued meeting so often.

INSTILLING GOOD WILL

To aid the workmen, the ventilation and lighting are well supervised. A general air of courtesy and good will prevails. We gave a turkey dinner in the boiler room on New Year's Day; the entire plant force was seated at an improvised table in the boiler room. While everything was served in the simplest, easiest way possible, it did not lessen our enjoyment of the turkey and trimmings. At the same time, we became better acquainted and friendly relations were more firmly cemented; discontent does not creep in so easily where one feels that he is in a congenial atmosphere, each working for the same end. Every employer has certain problems to meet for which there can be no specific remedy because he is dealing with individuals. A little tact and understanding will often iron out the difficulty and perhaps save a valuable man for some branch of the work.

If a man does a piece of work well, let him have due credit for his task, whether the credit be his bonus check or only a word of thanks or encouragement. Thrift should be encouraged; prosperous people are better workers. Kansas Power offers a splendid opportunity for investment in the sale of its stock which may be bought on the monthly plan.

I wish for space to tell of the splendid instances of coöperation I have enjoyed from the men who rank higher than I in the company and the men I meet every day at the plant; we like our work; our ambition is to push on to a more complete fulfillment of the meaning of the word "coöperation."

In beautifying and keeping our premises clean, we must be like a careful housewife, "eternally at it." A cleanup campaign to stimulate interest and thoroughly establish order is an excellent way to begin. The company paints the interior of this plant every two years; metal placards containing the words "All hands are requested to help keep this place clean" are posted conspicuously. These cards also help to remind the careless outsider that we dislike discarded cigar stubs thrown on our clean floors; cuspidors are provided.

Coal as a fuel is dirty but we use copper pans under the stokers to catch the fine particles. Steam lines are brushed once a week; boiler tops are brushed once a week in winter and once a month in summer. Each fireman is required to sweep boiler room once on each shift. All machinery in boiler room is wiped once on each shift. The janitor sweeps the turbine room twice each day and the boiler room once. Men do not tire so easily in a clean, well-ordered plant.

Trash cans are placed outside the building. All waste is placed in them. The yards are raked once a

week. Coal is kept well piled, not permitted to scatter over the yard.

Effect of Flowers in Beautification

To beautify the grounds, flowers are planted in every available space, choosing those which will provide spots of color. This is a particularly enjoyable phase of the work and I am looking forward to my tulip beds in the spring. There is an underground oil tank on the west side of the main building; this, covered with dirt, provided a bed for cannas of unusual beauty last summer. In planting the flowers, we follow the general rules of landscaping, using the taller plants for a background and the shorter ones in the foreground. Our flowers reward us for our work by the attractive air they give the place.

Methods of getting the men to coöperate in cleanliness and in beautifying are much the same as those used in producing greater efficiency. Every ambitious man wants a good job and to this type one can readily sell the idea of improving plant appearance. The seed of cleanliness, once planted, grows and spreads like a healthy plant. The men find themselves so much more comfortable; they are proud to have visitors see them at their work and explain the practical value to them of working in an establishment which is an important factor in the progress of the community. A direct benefit is derived from the association with such an institution which is not always understood.

In the Dodge City plant, we are fortunate in having ample room for everything; lockers and storerooms are labeled, that no time may be lost in locating needed supplies. Everyone appreciates this saving of time and steps.

Just as a clean, well-painted, clean-curtained house and well-ordered yard indicate the character of the people who dwell within, so does a clean place of business betoken the careful worker. Promotion goes first to the man who cares enough about his job to assist in the details of cleanliness and order. We all believe in the story of the servant who was faithful in the little things.

Oftentimes a man will be encountered who will object to careful routine of order and housecleaning and will regard it as needless. If the others around him are the careful kind, he will soon find himself unpopular for losing tools and creating havoc from which they must restore order. This unpopularity is often a sufficient remedy.

Demands made must be reasonable; there are many tasks to be performed around a plant which seem to stand things on end. The feeling of relief, when the dirty job is done, is another reason for cleanliness.

The plant at Dodge City is attractive in appearance and the many new improvements have aroused the pride of the entire force in their surroundings; however, even the humblest surroundings may be improved by care. Whenever a construction job is completed and the debris cleaned away, the improved appearance is an added incentive to clean up the old to match the new.

In general, I have found that the best results in cleanliness can be brought about by example and a careful nurturing of the idea. Doing the work systematically prevents accumulation of tasks. After these theories are carried out, you will soon find the entire personnel anxious to assist in the matter. It renders plant operating so much simpler that the idea will soon carry itself along. Indirectly the thing may be encouraged in a thousand different ways—a little sweeping here, a suggestion there, and soon the idea will be firmly rooted and later the definite reward of coöperation will be attained—a clean, efficient plant and attractive grounds.

Awards for Industrial Achievement

Industrialists as well as men in the shops and factories will be hereafter given public recognition for outstanding achievements in industry under a plan formulated by the officials of MacDonald Bros. Engineering Laboratories, Inc. of Massachusetts, the company formed to erect and operate the year-round permanent exposition of all kinds of industrial tools and equipment at Detroit.

Under this plan, the industrialist and the man in the shop who makes the most outstanding contribution to industry each year will be awarded gold medals and substantial cash prizes by MacDonald Bros. Engineering Laboratories, Inc., of Massachusetts. A committee composed of leading American industrialists will determine the conditions of the awards.

The purpose of the plan is not only to stimulate industrialists and factory employes to greater individual achievements but to give credit where credit is due.

H. E. MacDonald, vice-president and general manager of the laboratory organization, in announcing the plan of the company said that it is about time that proper recognition be given to men in industry for their achievements. Prizes are awarded each year to the persons making the outstanding contributions to the arts and some of the sciences but rarely does one hear about men in industry being rewarded, at least while they live, for extraordinary achievement. The Committee on awards will be appointed this year before the completion of the laboratory building in Detroit.

Electricity from India's Falling Waters

The projected Pykara hydroelectric scheme is one of the most comprehensive yet conceived in connection with the development of India's water-power resources. The plan is to make use of the falling waters of the Pykara River, which has a drop of 2050 ft. from the Nilgiri Hills to the plains below. The site selected for the dam is 3 mi. above the falls, giving a total head of water of 3088 ft. This dam will have a storage capacity of not less than 4,000,000,000 cu. ft. and to guard against droughts, other storage basins are to be provided.

Initially, three generating sets—each of 7500-kw. capacity, are to be placed in the power house, which is to be built large enough to accommodate two more units of this size. Provision is also to be made for two other generating sets of 15,000 kw. each, which are to be installed as soon as the demand for power warrants the additional equipment. The current is to be transmitted by overhead wires to Coimbatore, Pollachi, Trichinopoli and possibly to Madura, all in the Madras Presidency.

Engineers Shown Tricks of Stage Lighting

MORE THAN a thousand members and guests attended a joint meeting of the Chicago Section, Illuminating Engineering Society and the Western Society of Engineers in the new Chicago Civic Opera House, on Thursday evening, Feb. 20, and took advantage of the opportunity to go up on the stage and examine the equipment.

E. D. Tillson of the lighting division of the Commonwealth Edison Co. opened the meeting with a brief but interesting description of the auditorium lighting. He was followed by T. E. Johntz of the engineering department, General Electric Co., who described the highly perfected motor-operated, vacuum tube control equipment that is used in the control of the thousands of lights used on the stage and in the auditorium. He explained each of the different control units and exhibited samples of each.

Then the curtain was raised, disclosing the stage set with some of the scenery from the opera "Iris" on which Edward H. Moore, for many years chief electrician of the Civic Opera Co., demonstrated just a few of the lighting effects that can be produced in order to show the range of possibilities.

This is by far the largest and most complete lighting installation in any opera or theater building and introduces a great many new features which overcome difficulties heretofore encountered. The stage, itself, is enormous. It would be possible to stand a 14-story building on it underneath the gridiron. Every scene can be lifted bodily out of sight, thus leaving the floor clear.

The dimming equipment comprises a saturated iron core reactor in the main lighting circuits, the direct current winding of which is excited from a Thyratron rectifying tube. The direct current output of this tube is a function of the phase angle displacement of the alternating current and voltage impressed upon the grid of the Thyratron. This phase displacement in turn is controlled by a phase modulator operated directly by a receiving Selsyn motor. Since this Selsyn motor follows the movements of the transmitter Selsyn motor, the phase angle displacement produced by the phase modulator is proportional to the movement of the sender motor. By this means, the lights can be brought from full brilliancy to full dimming with no perceptible variations in illumination intensity. The value of the alternating current passing through the iron core reactor is dependent upon the degree of direct current excitation. With no direct current field, the reactance of the reactor is a maximum while, with full direct current excitation, it is a minimum permitting unimpeded flow of alternating current. This of course corresponds to full brilliancy of the lights.

All lighting control circuits are in duplicate and are so arranged that the lighting settings for one scene can be made while another scene is in progress. Once the proper settings are made, the operations follow in correct sequence automatically.

DO NOT STOP a chain grate stoker for any length of time with the hopper full of coal, as the fire will burn forward and injure the grate.

Oil Makes a Clean, Easily-Handled Fuel When Available at Competitive Prices

FUEL OIL plays an important part in the power plants of this country, not only as a fuel supply for Diesel engines but also for use in steam plants in certain sections of the country. As a rule, it is the residue that remains after the lighter oils, naphtha, gasoline, distillate, and kerosene have been removed from the crude oil obtained from wells. A few of the heavier crudes with an asphalt base have so low a gasoline yield that they are sometimes used as fuel direct. Of late years, improvements in refining methods have been marked, and the residue sometimes difficult to burn in furnaces much less in engines.

The most apparent difference in fuel oils is their specific gravity or density, usually expressed as degrees Beaumé or A.P.I., the latter standing for American Petroleum Institute scale, practically the same as the Beaumé. As a rule, the heavier oils have a higher viscosity, are thick and do not flow readily. On the other hand, heavy oils are usually cheaper and have a greater heat content per gallon than light oil. Handling can be facilitated by heating.

From the standpoint of cleanliness and ease of combustion control fuel oil ranks close to gas and has an advantage over gas in that it can be easily stored. It is easier to handle than coal as for the same heat content it is about 30 per cent lighter. An average fuel oil value may be taken as 18,500 B.t.u. per lb. and coal as 12,500 B.t.u. per lb.

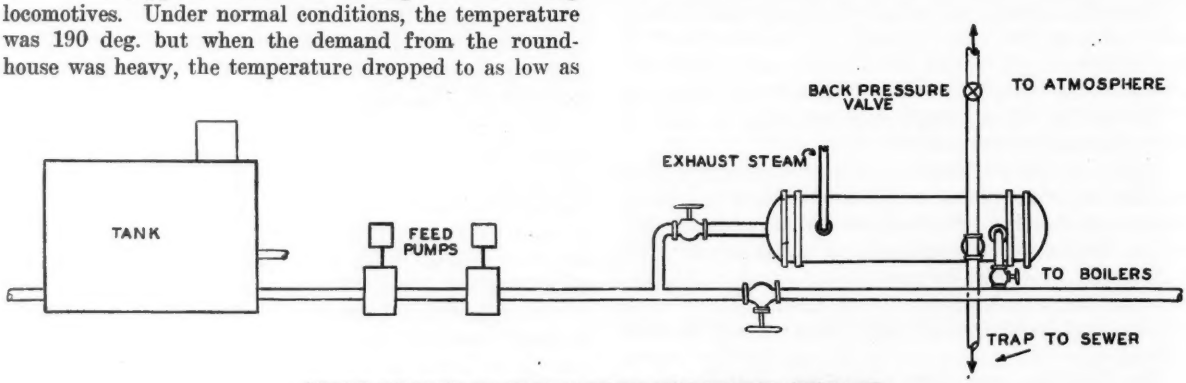
Storage is usually made in underground tanks which in large plants are usually made of concrete and placed near a railroad, so that the oil can be unloaded by gravity. Steel tanks above ground are preferred by some so that leakage can be readily detected. Even though a light oil is to be used, facilities for handling heavy oil should be provided, as market conditions vary and heavier oils may occasionally be advisable, if not necessary. Such facilities consist of steam or hot-water coils in the storage tanks to heat the oil before it enters the pump suction and another heater on the discharge side of the pump to bring the temperature up to the best point for atomization at the burner. Heater arrangements differ considerably with the equipment installed.

Many types of burners are used, some using compressed air or steam for atomizing the oil at the burner tip; others, known as the mechanical type, are supplied with oil under pressure, atomization being accomplished by burner tip design and high whirling velocity of the escaping oil.

ALTERNATING-CURRENT motor and generator speeds are determined by the frequency of the circuit and the number of poles built in the machine. The synchronous speed in revolutions per minute is equal to 120 times the frequency of the circuit in cycles per second divided by the number of poles. Thus a two-pole motor on a 60-cycle circuit would have a speed of 3600 r.p.m., a four-pole motor 1800, a six-pole motor 1200 and so on down. Similarly on a 50-cycle circuit the speeds would be 3000, 1500 and 750 respectively for a two, four and six-pole machine.

Exhaust Steam Put to Work

OUR FEEDWATER supply is taken from a storage tank which also supplies water for washing out and filling locomotives. Under normal conditions, the temperature was 190 deg. but when the demand from the roundhouse was heavy, the temperature dropped to as low as 140 deg., which raised the deuce with the steam pressure and coal consumption.



SPARE HEATER IN SERIES WITH HOT WATER STORAGE

On our hot water heating system were two heaters, one for exhaust the other for high-pressure steam, the latter of which was never used. I got authority to make changes so this could be converted to a feedwater heater, with the proviso that, if it were ever needed for building heating, it could easily be changed back.

Arrangement of the water storage tank was as at A. The extra heater was connected between feed pumps and boiler as shown at B, so that the exhaust steam is not in contact with feedwater, condensate going to the sewer. The heater may be bypassed whenever desired but, when working, keeps the feedwater temperature up to from 210 to 212 deg. with a saving in fuel and, even more important, a steadying of boiler conditions.

Mechanicsville, N. Y. R. F. LEACH.

Wire Drawing on Light Loads Damages Reducing Valves

MANY MEN buy two-pants suits so that when the one pair fails, they have the other. It used to be the custom, also, years ago, to allow plenty of material in the suit so that it could be let out as required. The same practice seems to be followed in ordering reducing valves, many engineers ordering a valve much too big for the job with the thought that perhaps the load may increase and still come within the capacity of the reducing valve. This practice is not good and, in many instances, may give considerable trouble before the reason for the difficulties is found. A typical instance may serve to emphasize this point and, incidentally, bring out some interesting information about reducing valves, which is usually overlooked.

In the plant in question, a reducing valve had been installed to deliver a load which had been estimated originally at about 10,000 lb. of steam per hr. This estimate had been based on the estimated boiler and furnace efficiency, figured upon coal consumption. As a matter of fact, neither the boiler, furnace nor overall efficiency were anywhere near what they were thought to be, the load being more nearly 6000 lb. of steam. Moreover, the load varied between wide extremes during the course of the 24 hr. so that for many hours during the 24, the load was in the neighborhood of about 2500 lb. of steam per hr. The steam pressure at the inlet side of the reducing valve was supposed to be 150 lb.; the pressure on the delivery side was supposed to be 110 lb.

Following a short service complaint was made that the valve seats were badly cut and that new seats were required. Assuming that the valve seats were possibly defective, these were replaced, the owner being given the benefit of the doubt by the manufacturer of the reducing valve. Soon another complaint came in that the valve seats were badly cut. This was repeated several times, causing the engineer of the plant to decide that the valve was unsatisfactory, that he would have

to adopt some other make of valve and that he was entitled, therefore, to some credit on his former purchase, which had failed to deliver the goods.

An investigation soon indicated the cause of trouble which was in no way chargeable to the manufacturer of the valve, although the valve itself was the cause of the trouble. The situation was this: The valve had been ordered of ample capacity for future growth of load. In other words, it was much too big for the job. The result was that, instead of being wide open at the so-called full load, the valve was never full open as the total load never was greater than 7500 lb. of steam per hr. instead of 10,000. When the load decreased to about 2000, the valve lift necessary to pass this amount of steam was very small, the actual opening between the valve seats was greatly constricted and wiredrawing occurred during quite a large part of the time. A later examination showed that the steam was wet, which still further increased the wiredrawing and deterioration of the valve seat. It is well to point out that wet steam carries globules of water suspended in the steam. When the steam travels at high velocity through a small orifice such as valve seats that are merely cracked open, the valve seats become badly cut by the water. This is what happened in the present instance. The remedy, of course, was to install a smaller valve; one having a maximum capacity of about 7000 lb. of steam per hr. instead of 10,000.

Choice of a reducing valve should depend upon the maximum and minimum loads as well as on the received and delivered pressures. Another thing, wet steam is objectionable even with steam turbines and is a source of continual destruction and inefficiency creating damage to all valves through which it passes. It is a hazard in the case of a reciprocating engine.

Chicago, Ill. C. G. Crowley.

Bulge in Boiler Shell

One day a young friend came into my plant with worry written all over his face. "Who killed your pet canary?" I asked him. "Canary, nothing," said he. "My boiler has a wen about 5 in. across on its bottom. Sticks out about 2 in. The fireman is so scared he'll probably leave unless I get it fixed. The boiler maker wants to operate—cut out the wen and put on a patch but the inspector won't have it and says, 'Go on, operate. It's safe unless it gets worse. But watch it!' Maybe it's safe but it looks scary and I want to know how to fix it."

So I sat me down with my pipe and pencil and a sheet of paper to unscare the youngster and show him how to unbulge the wen. Here's the story.

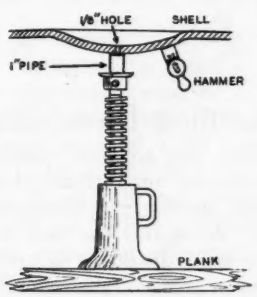
First off, the bulge was probably caused by dirt collecting and caking on the inside of the shell just where the fire was hottest. Water couldn't get to the plate to carry away heat fast enough so the plate became overheated and the pressure stretched it. The stretching broke up the cake of dirt so that water could get to the plate and the bulging stopped. So long as water gets to the plate it will not likely bulge any more but a bulge is an easy place for sediment to form, so the bulge must be kept cleaned out. That's why you have to "watch it!" Keep it clean and it may serve for years.

As to safety, when the plate bulged it stretched some so that, for your size of wen, it may be thinner than the rest of the plate by the thickness of a sheet of paper. Nothing to get panicky about, so long as there are no signs of cracks or blisters. If these show, the plate was probably burned and greatly weakened. Then, for safety's sake don't operate.

Don't patch, either. The patch would go on the outside and leave a nice pocket for dirt and scale that just couldn't be kept clean. So soon you would have another bulge, probably worse than the first. The only safe patch, in such a case, is a whole new plate section.

You can take out the bulge, if you work carefully, with no injury to the plate and leave hardly a trace of the occurrence. It's best before starting, however, to drill a small hole, say ⅛ in. diameter at the point of the bulge and find out just how thick the metal is. If it is much less than the original plate thickness, better put in a new plate.

If it seems all right, remove the grate bars below the bulge and build up heavy planking to give support to



JACK TAKES THE BULGE OUT OF THE BOILER

the foot of a screw jack, set to bear on the center of the bulge at right angles to the shell.

Put a couple of buckets of clean, dry sand on the inside of the shell at the bulge to help hold the heat and put a piece of 1-in. pipe between the cap of the jack and the point of the bulge.

Procure two big blow torches, capable of heating the bulge to a dull red. Two men will be needed with heavy hand hammers to drive back the bulge when it is heated and it's best to have a dress rehearsal before heating, so that the men will know exactly what they're to do.

With everything in place and everybody ready, heat the bulge with the torches, putting on a gentle pressure with the jack. As soon as the metal begins to give, the men should drive back on the bulge, working from the outside in, driving carefully a little at a time and round and round the bulge. The jack should be screwed up only as fast as the metal is driven back by hammering, so as to keep a firm pressure at all times but not dent the center inward.

Time will be required to do a good job and probably three or four heatings. At the last, the center will be hammered back with the jack removed. If carefully done, the plate will look like new and the small center hole can be closed by a machine screw, tapped in.

Indianapolis, Ind. James Hobart.

Stuffing-boxes of boiler feed pumps have been found to be a possible source of oxygen entrance into feedwater.

Effective Treatment for Hard Boiler Scale

FORMERLY the scale at the bottom of my return tubular boilers had to be removed by a hammer and chisel, hence it was necessary for a man to go inside of the boiler to do this work. At that time, it was the custom to wash out the boiler on Sundays.

By the use of boiler feedwater treatment applied on Saturdays and allowed to stand in the boiler for a day, removal of this scale has become an easy matter. After the boiler is washed out on Saturday, 25 lb. of the compound, which has previously been dissolved, is poured in through the bottom manhole. After replacement of the manhole plate, about 2½ ft. of hot water is admitted and allowed to stand until Sunday. By this soaking process in a strong solution, the scale becomes soft so that it can be washed out readily. After this is done, the boiler is filled with clean water and is ready for steam making again.

The above method has been used for the past three months, during which I have not been bothered with hard scale.

Seymour, Conn. CHARLES MEHR.

Overhauling Diesel Engines

DIESEL ENGINES, like all other machines, need to be periodically overhauled for internal cleaning, detecting wear and making necessary adjustments. The piston needs attention. When this has been removed from its liner, the piston head should be scraped to remove all carbon, the piston rings removed and any carbon scraped from the grooves. The inside of the grooves should then be examined for the formation of ridges at the sides and near the bottoms, as such ridges hinder the free movement of the rings. If found to exist, they should be removed with a fine file, to avoid trouble, particularly if new rings are fitted.

To detect any wear of the rings, they should be put in the liner and the gap measured at the joint. If this exceeds one-sixteenth inch, the ring should be replaced by a new one. The piston pin should be removed and measured for wear with a micrometer. This wear should not exceed 0.002 in. for each 1½ in. of pin diameter.

When replacing the pin, it should be turned at right angles to its previous position, so that the wear due to the piston thrust will be on another surface. The lubricating pipe to the piston pin should also be cleaned.

Cleaning out of the lubrication holes in the liner is conveniently done with a small twist drill. All the lubricating pipes should be blown out by steam or compressed air to remove any dirt and, before the piston is replaced, the pipes should be filled with clean lubricating oil, for, if the pipes were left empty, some time would elapse after the engine was started before the pipes would fill with oil. It is usually sufficient, if the piston is withdrawn after 4800-hr. running periods, although engines have run much longer than this without overhauling.

If the rings have become too much worn and have lost their spring, they will permit gas leakage past the piston, which will lower the compression pressure. Gas leakage past the piston is frequently due to the liner wearing out of round. A certain amount of wear is bound to take place on both the liner and piston rings; but as there is a tendency for both to wear elliptical, while the old rings are in use a gas tight seal may be maintained. If, in this case, new rings are put on the piston, gas leakage will result. Replacement of all of the rings on one piston should not be made at one time; it is best to replace one at each overhaul period, which will give the rings time to wear to the liner. After say 2000-hr. running, the new rings will be worn to the liner sufficiently to be gas tight, while in the meantime, the piston will have been kept gas tight by the old rings.

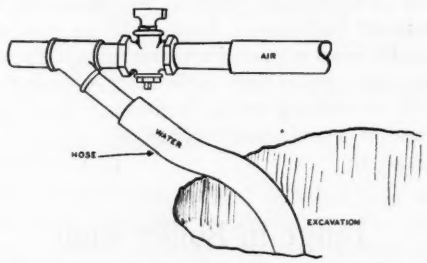
Lengthwise movement of the main shaft should be checked. This movement should not exceed 0.016 in. or wear will result. The diametrical clearance on the main bearings should be checked and, if found to be excessive, adjusted. Excessive play in the bearings causes knocking and vibration.

Record should be kept of all adjustments or replacements made and notes on the wear of the various parts should be kept for future reference.

Brighton, England. W. E. WARNER.

Compressed Air Siphon

DURING SOME alterations around a switchboard in a small power house, an excavation was required where work had to be done in changing the mains leading to



AIR LIFTS WATER FROM EXCAVATION THROUGH SIMPLE CONNECTIONS

the switchboard. The hole, which was about 6 ft. square and about 6 ft. deep, kept filling with water, retarding the work.

With a few pieces of pipe and some rubber hose, the simple siphon shown in the illustration was made and used to keep the hole free of water. Air was easily available, as there was a large compressor in the same room where the work was being done. In the morning, the hole would be full of water, which was quickly emptied by means of the siphon. Later the siphon would be run for 5 or 10 min. at intervals of about a half hour.

Syracuse, N. Y. H. L. WHEELER.

JANUARY SALES of mechanical stokers, as reported to the Department of Commerce by the 10 leading manufacturers in the industry, totaled 54 with 13,607 hp., as compared with 79 of 44,976 hp. in December and 97 of 42,392 hp. in January, 1929.

THERE SHOULD always be a slight leakage from centrifugal pump stuffing-boxes in order to cool and lubricate the packing.

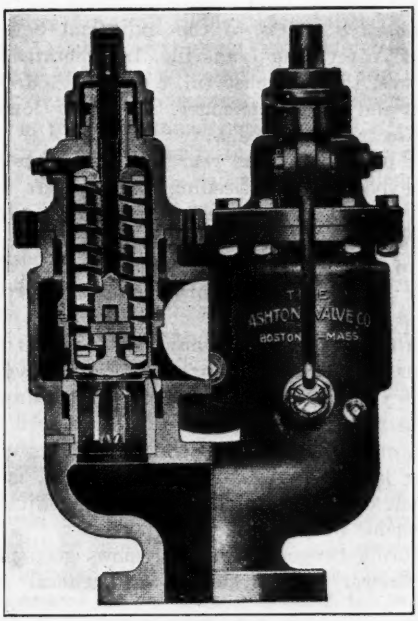
Questions and Answers

Safety Valve Setting

How MAY I reset a safety valve properly when the desired blowoff pressure is to be raised from 105 to 120 lb.?

Should I reset the valve myself or have a boiler inspector do it? I am a licensed fireman but I have never set a safety valve. J. P.

A. In some states, it is unlawful for an operator to change the setting of a safety valve. It is best to take the matter up with your local boiler inspector, or,



DOUBLE SPRING LOADED POP SAFETY VALVE

if there is no local representative, with the State Board of Boiler Inspection located at the capital of your state.

For pop-safety valves, change of adjustment must be made by trial. Spring loaded safety valves differ in detail design but all are adjusted by changing the tension on the spring. If the valve is to blow at a higher pressure, the screw which regulates the amount of compression on the spring must be screwed down, the actual amount being determined by trial. The cap over the top of the adjusting screw is first removed and the screw turned down a small amount, the number of turns being noted. Probably only a fraction of a turn will be needed. The boiler pressure is then raised and the pressure at which the valve blows noted. This will give an indication of the approximate amount the screw must be turned down for the pressure desired. The exact amount must be found by trial.

Power Required by Brine Circulating Pump

CALCULATION for the horsepower required by a brine circulating pump published on page 1319 of the December 1, 1929 issue contained the following misstatement and error.

The second paragraph, in discussing heat picked up by the brine, should say:

"If the brine rises 4 deg. F. each time it goes through the cooler, it will carry 4×0.7025, or 2.81 B.t.u. per lb. pumped."

In the third paragraph, to derive foot-pounds per minute, in order to determine horsepower, the pounds of brine pumped per minute must be multiplied by the head in feet, not head in pounds. The equivalent of a head of 20 lb. with brine of 1.218 specific gravity is $(20 \times 2.31) \div 1.218 = 37.9$ ft. This gives $1780 \times 37.9 = 67{,}400$ ft.-lb. of work per minute. The horsepower required will be $67{,}400 \div (33{,}000 \times 0.80) = 2.55$ hp. at 80 per cent pump efficiency, instead of 1.35 as found in the original article.

Davis, Calif. R. L. PERRY.

Reversal of Shaft Governors

CAN A SHAFT governor be so adjusted that it will govern an engine when it runs in an opposite direction? If this can be done, how is it accomplished? J. O. L.

A. An inertia shaft or flywheel governor can be reversed in order to operate properly when an engine runs in a direction opposite to that for which it was originally intended. This is done by turning the flywheel end for end so that when the engine runs in the opposite direction desired, the governor weight will lag in the direction of running in a manner similar to that in which it operated before reversal.

Effect of Intense Local Heating on Boiler

WHAT EFFECT will constant, intense heat have on one point of a boiler? Is there danger of buckling or rolling due to such concentration of heat? F. S.

A. No ill effect such as buckling or rolling will be experienced when intense local heating occurs in a boiler if freely circulating water is on the cooling side.

Increased evaporation at a highly heated local spot would be effected and this may cause the formation of a greater accumulation of scale at that point which may cause bagging but no trouble will occur if the plate is kept clean and water circulates freely on the cooling side.

Editorial Comment

Optimists

Executives of public utilities know that, if they provide too much plant capacity, it means investment on whose cost interest must be paid to bondholders with no offsetting income from which to pay. They plan for construction, therefore, only after most careful survey of past growth and future probabilities. When they are optimists, it is judgment based on facts, not mere hopes.

It is of interest, therefore, to compare the statements of executives from many centers of industry as to the business of 1929 and prospects for 1930.

John J. O'Brien, president of H. M. Byllesby & Co., after considering reports from his staff, says:

"There is every reason to believe that the electric and gas industries will continue to expand and increase earnings at a substantial rate during 1930. Construction programs, as already planned and announced, are large, and were made to serve increasing public demands of a fundamental character. Major projects, so far as I know, will be carried out as planned in 1930 in the absence of anything in the present situation to warrant lack of confidence in the growth and prosperity of the United States."

He recognizes, too, that growth of industrial plants is to be expected as better practice brings about higher efficiency in such plants. He says:

"One important phase of electric and gas development deserves careful consideration by the public and its lawmakers. This is the sharply increasing degree of competition which both these industries face in their future progress. Electric power from central stations now has to fight its way against higher efficiencies than formerly obtained in isolated plants, both steam and internal combustion engines. Over production of coal and oil cause lower prices of fuel."

Covering widely separated parts of the country are the following forecasts for this year.

R. F. Pack, vice-president and general manager, Northern States Power Co., says:

"There are good reasons for believing that the central northwest states in which the Northern States Power Co. operates will experience a good business year in 1930. There is no boom in sight, no indication of record-breaking business and industrial activities, but it is fair to prophesy that this part of the country during 1930 is going to progress in a commercial, industrial and agricultural way."

For Oklahoma, J. F. Owens, vice-president and general manager, Oklahoma Gas & Electric Co., speaks:

"The territory served by the Oklahoma Gas & Electric Co. has enjoyed an unusual growth during the past year.

"There is every indication that the growth of the territory served by this company will be even greater in 1930 than in 1929."

Of the Pittsburgh territory, Frank R. Phillips, senior vice-president of the Philadelphia Co., says:

"On the whole, the year 1929 has been a generally satisfactory one for our Pittsburgh properties. The Duquesne Light Co. enjoyed what promises to be the best year in its history. A number of new records were made.

"We are not anticipating any extreme depression and are vigorously pushing construction of the James H. Reed Power Station on Brunot Island and the completion of the Twelfth Street Steam Heating Plant."

From T. B. Wilson, vice-president and general manager, Louisville Gas & Electric Co., comes the following:

"The steady progress which Louisville has made in the last 10 yr. was continued in 1929, but of probably greater moment to the citizens was the apparent evidence that during 1930 Louisville would begin to feel the cumulative effects of the industrial development efforts of Advertising Louisville, Incorporated."

Out west they are cheerful, too. W. F. Raber, vice-president and general manager, San Diego Consolidated Gas & Electric Co., speaks:

"Our business for the year just ended was fully up to our expectations, exceeding slightly our estimates made a year ago. The percentage of increased consumption of gas and electric energy was about double the percentage of increase in gross revenue.

"Our business should continue to show reasonable growth in 1930."

From Colorado, W. N. Clark, vice-president and general manager, Southern Colorado Power Co., sends this:

"The year 1929 has been one of expansion and growth in most of our districts which has been offset by a loss in one gold mining district served.

"Our largest industry, the steel works, is reaping the benefit of past expenditures for rehabilitation and improvements of the local plant."

California Oregon Power Co. shows good prospects. C. M. Brewer, vice-president and general manager, states:

"A resume of the activities of Mountain States Power Co. for 1929 indicates a substantial increase in business over the preceding year. Throughout the territory served, which includes over one hundred communities located in six states, a steady and consistent growth has been in evidence.

"In reviewing the growth and development of the territory served by this company during the past year, it is with a feeling of optimism that we look forward to 1930 which it is contemplated will bring at least a normal increase in connected load and number of customers served.

And from J. P. Pulliam, vice-president and general manager, Wisconsin Public Service Corp., comes this:

"During the year 1929 we added 300 mi. of rural lines to our system to serve 1000 customers, which brings our total of rural up to 3000. Rural development shows a healthy increase at all points.

"We enter 1930 better equipped than ever to render

service to the territory we serve and have the firm conviction that the year's results will show continued progress."

Thus city and country, steel, oil, cotton, mining and grain sections are looking for a good year. Based on careful survey of the fields rather than wishes, these executives go on record as optimists.

Off Duty

Four men were engaged in a conversation which, as many conversations go, was mostly about the weather.

"Well," remarked one of them, "the sun has been up two hours here. The wind is blowing a gale, snow is piling into impassable drifts and automobiles are abandoned at the roadsides. It's a fine winter morning." It was 8:30 on a Tuesday morning in February and the speaker was in Schenectady, N. Y.

"I'm never going to shovel another flake of snow," replied another of the group. "We won't see the sun for another hour here this Tuesday morning but the weather, *as always in California* is very comfortable." This speaker was in Oakland.

"Snow sounds good to us," ventured the third speaker from far-away Sidney, Australia. "It's bedtime here, 11:30 Tuesday night, but many folk are still down at the beach enjoying surf bathing and trying to get relief from 90 deg. temperature and the oppressive humidity of this midsummer night."

The fourth participant in this conversation evidently was sleepy for thus far he had maintained silence. Now he yawned wearily across ten thousand miles from Wellington, New Zealand. "You fellows can keep this up if you want to but I'm going to turn in. Anyway it's time for us to sign off; 12:30 Wednesday morning and delightful summer weather. Snow? What's snow?"

Sometimes the speakers became a bit confused. At one time, the Schenectady speaker thought he was addressing the man in Oakland, California, only to find that it was Australia answering him and Oakland laughing at the mistake.

Such are the marvels of short wave radio. Listeners tuned in to Schenectady's (WGY) wave length sat back and enjoyed the performance, although at times they were hopelessly jumbled as to time and seasons. The signals originated in the summer and in the winter, in the daytime and during the night, all at the same time. Signals starting out tonight, for example, were heard this morning and signals originating tomorrow arrived today.

This, despite all we have come to know about radio sounds uncanny and impossible; yet it actually happened. Early in February, radio engineers of the General Electric Co. established a working experimental schedule with Amalgamated Wireless Australasia, Ltd., of Sidney, Australia. On successive Tuesday mornings, starting at 5 o'clock eastern standard time, a two-way talking circuit was established. Schenectady talked through W2XAF, the 31.48-meter station and Sidney engineers talked through VK2ME, the 28.8-meter station. On Feb. 11 the operator at 2YA at Wellington, New Zealand, came on the air with Sidney and Schenectady, and then W6XN, the General Electric short-wave station at Oakland, came in, making it a four-way party circuit with all parties in at once, exchanging greetings and discussing the weather and time.

The four-party circuit was not as simple as it sounds, for W6XN at Oakland at one time could not hear W2XAF. The trouble was adjusted, however, by getting W2XAF as rebroadcast by VK2ME, Sidney. In other words, Oakland heard Schenectady after the voice had traveled across the American continent once and the Pacific Ocean twice, a distance of 17,000 mi.

Think of what this means! Those of you who are prone to take things for granted, who turn on your high-powered, factory-built radio receiver with never a thought of the tremendous technical achievements which lie behind its camouflaged Grand Rapids exterior, just stop and consider for a moment. Try and picture, if you can, by what strange power voices can be sent over those thousands and thousands of miles—over plain, mountain and sea, in the wink of an eyelash. From Boston to California at the time of Richard Henry Dana's "Two Years Before the Mast" was a matter many months. A Pacific crossing meant another two or three months. Even today the fastest Empress lines require 24 days from Vancouver to Sidney.

Yet, at a time which can be described neither as winter nor summer, day nor night, four men on opposite sides of the world carry on a conversation as though they were in the same room.

What wizardy is this, that in this strange manner, by means of a few bits of wire, a couple of little glass bottles with lights inside, and a shimmying crystal of quartz, thus annihilates space and time? What species of genie is it that is thus able to hurl spoken words and seductive music across the boundless skies to the far-flung corners of the earth, unseen, unheard, unknown? These Aladdins in their laboratories, with their magic lamps and crystals—do they know this genie? Evidently, for at their command he leaps forth from his hiding place, from as James Branch Cabell would say, the grey wastes behind the moon, to carry their messages on the wings of light. His demands for these services are trivial. An ordinary 60-watt lamp represents a very small amount of electrical power as such things go; a five-watt lamp very much less. Yet this is all the power the genie requires to carry a message over ten thousand miles of space.

From every direction, the wonders of science are showered upon us. From the laboratory of the astrophysicist come unbelievable accounts of the inconceivable immensities of the stellar universe—of suns a million times larger than ours, of external universes so far distant that it takes light a thousand million years to travel from them. From the biological laboratories come fascinating stories of unseen worlds below ours, of battles between armies of micro-organisms to whom our bodies are worlds. Similarly, the atomic physicist tells us of the marvels of the structure of the atom, of geometrical perfection and beautiful order beyond our comprehension. All of these things are wonderful and instill in one a sense of reverence and awe, but none of them so transcend the powers of the human mind to conceive, as does the hurling of so transitory a thing as a voice wave around this planet.

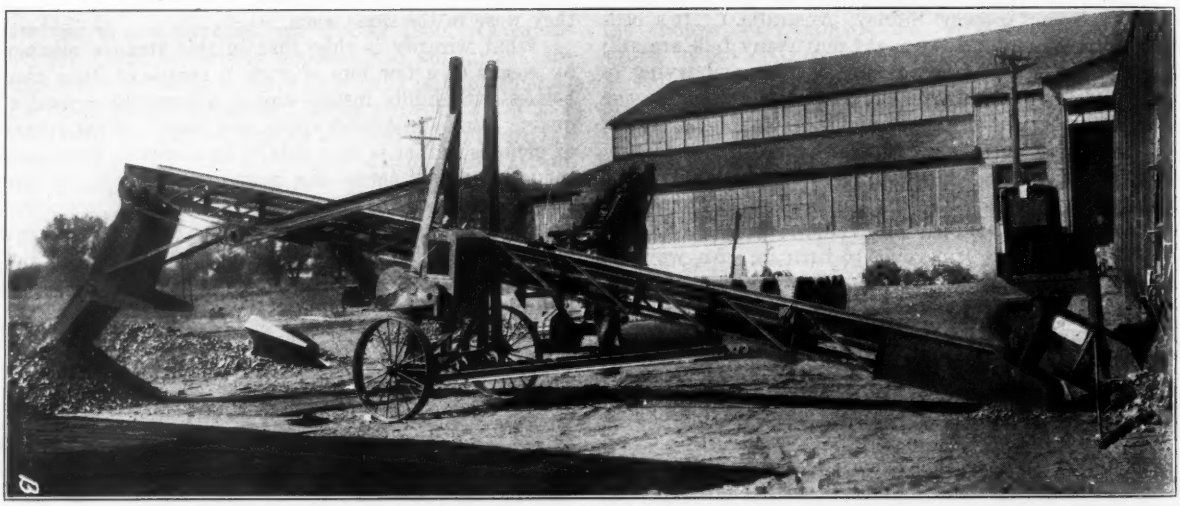
Some evening when you are dissatisfied with what emanates from your radio receiver and when you swear by all the gods that the first person who comes along can buy the thing for a dollar, calm your ire and think of what the set means in terms of human thought and achievement. Maybe it will take on a different aspect and maybe you won't want to sell it so readily.

Power Plant Engineering Developments and News

Flight Conveyors for Handling 1 T. a Minute

TWO NEW DRAG-TYPE machines, the Model 55 and the Model 56 plain flight conveyors, have been added to its line by the Barber-Greene Co., Aurora, Ill.

The Model 55 plain flight conveyor is built for a handling capacity of a ton of coal a minute. The boom is sectional in construction and the machine may be had in boom lengths of 24 ft., 30 ft. and 39 ft., according to the purchaser's requirements. Flights are deep and cupped to enable them to exert a digging action and the chain of the flight line is constructed with specially wide wearing surfaces.



MODEL 55 PLAIN FLIGHT CONVEYOR WITH GASOLINE ENGINE DRIVE

The truck is built with swivel wheels to allow the machine to build large storage piles without moving the actual feeding point. Mounted on the truck is the power unit—either an 8-hp. LeRoi gasoline engine or an 1800-r.p.m. electric motor. The power unit is so mounted that it remains vertical regardless of the angle at which the truck may be operating. Thus lubrication is not impaired by the tilting of the truck. This independent engine mounting also has the advantage of keeping vibration away from the conveyor boom.

Drive on the Model 55 machine is by chain to the head end, relayed by three chain units: one from the motor to a sprocket on the truck mast at the point where the upper boom support arms begin, the second from the base of the upper boom support arm to the point at which it joins the boom and the third on the opposite side of the boom to insure better balance—to the head shaft. The advantage claimed for this three-unit drive is that no matter whether the boom is at its minimum height or raised to its fullest extent, the tension on the drive chains does not vary and the necessity for drive chain takeups is eliminated.

This conveyor is equipped with a power boom hoist of the self-locking worm type, which is engaged by means of a hand lever near the power unit. By means of the power hoist, it is possible to raise the discharge end of the machine as the pile grows higher, so that the coal need never fall more than a few inches. The boom may be raised or lowered while the machine is in operation.

The Model 56 plain flight conveyor is a smaller machine than the Model 55, the maximum available boom length being 24 ft. It is powered by electric motor only and the boom is raised and lowered by means of a hand winch and spur gear mounted on the truck. It also has a capacity of a ton of coal a minute.

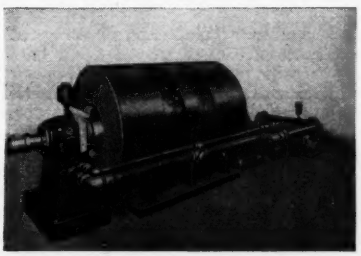
Combined Speed Counter and Stop Watch

COMBINED SPEED COUNTER and stop watch, recently developed, is designed to enable one man to read speeds conveniently. In this instrument the counter and the works of a watch have been combined so that they are simultaneously thrown in and out of gear. The driving

spindle runs idle, so that when it is inserted in the center of the shaft whose speed is to be measured, the driving spindle revolves but does not drive the counter. To make it drive, the instrument is merely pressed strongly against the shaft, when the counter and stop watch will start simultaneously. As soon as the pressure is relieved, stop watch and counter can be read. Pressure on a small knob on the watch brings its hand back to zero and winds the watch for the next reading. The counter is reset to zero by a turn of a second knob. This combination speed counter and watch is marketed by Montgomery & Co., Inc., 292 Lafayette St., New York City.

Westinghouse Develops New 3600-R. P. M. Induction Motors

FOR USE IN DRIVING high speed machinery, the Westinghouse Electric & Manufacturing Co. has recently developed a line of 3600-r.p.m. induction motors. These motors have high efficiency and power



NEW HIGH SPEED INDUCTION MOTOR

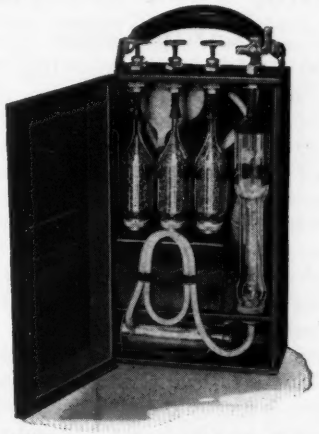
factor even at light load and the starting currents are low. They are small in size, requiring little space and the largest one built to date weighs only 7700 lb. Ratings of 500 hp. up through 1250 hp. have been built and are now in service but if more power is required, the line can be readily extended.

One-piece punchings of silicon steel are used in both stator and rotor.

Improved Gas Analyzer

CHANGES in this line of gas analyzers (orsats) are announced by The Hays Corp., Michigan City, Ind. Six standard ranges are available in a light weight metal carrying case weighing 8 lb. complete and measuring 15 in. high, 7¾ in. wide and 4¼ in. deep. In addition, there are three special ranges available in a slightly larger case.

Features of the new Hays improved gas analyzer are stated as follows: 1. Light weight and compact design. 2. Heavy molded glass absorption pipettes, attached to the molded hard rubber chemical bottles with soft rubber gaskets and finger compression nuts. 3. Steel wool surface method of absorption of the gases, intended to make it possible to take a CO_2 reading in 30 sec. and a complete analysis for CO_2, O_2 and CO in from 4 to 5 min. 4. Monel metal needle valves and renewable nickel needle valve seats, instead of pinch clamps and glass stop cocks. 5. Molded hard rubber chemical bottles held in place by slidable flat spring which can be raised after loosening the holding screw, to permit disassembly of the entire instrument for cleaning. Only a pair of pliers and a screwdriver are neded to disassemble the instrument, it is claimed. 6. Owing to the method of supporting the few glass parts in the metal case, there is little danger of breakage. All parts, however, are designed to be easily renewable in the field. 7. The instrument may be carried in any position without the liability

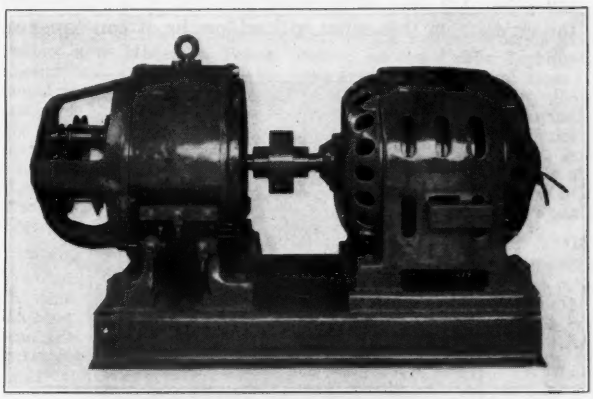


NEW HAYS GAS ANALYZER

of spilling or mixing the solutions. 8. The leveling bottle and the aspirator and tubing are clamped inside the case after completion of tests. When the doors are closed all accessories are inside the carrying case, with the tubing so arranged on convenient reels to prevent kinking.

Welded Bases for Motor-Generator Sets

RELIANCE ELECTRIC & ENGINEERING Co., Ivanhoe Road, Cleveland, O., has adopted bases constructed from heavy steel plate, electrically welded for motor-generator sets which it manufactures in sizes up to 250



BASE WITH SHIMS AND PADS WELDED TO IT, TO PRESERVE ALINEMENT

kw. Tops and ends of the welded bases are completely closed so that no dirt can collect underneath.

Pads upon which the motor and the generator rest are lined up horizontally and vertically by using the machines themselves as patterns for doing the alining Such shims as are needed are placed between the pads

and the base. The pads with the shims beneath are then welded to the base. Horizontal alinement is maintained by tight-fitting dowels. These are driven into the pads, through two diagonally opposite feet of each unit. One or more units may be removed from the base without worry about the alinement when they are to be replaced.

Grooving Tools for Victaulic Couplings

FOR GROOVING the ends of pipe from ½ in. to 16 in. to take Victaulic couplings, Beaver grooving tools have recently been placed on the market. These are designed to cut a perfect circle on the pipe even though the pipe itself may be out of round. This is desirable, to secure best results with Victaulic couplings, in which two housings clamped together by bolts hold a leak-proof ring over the pipe ends where they come together.

Action of the Beaver grooving tool for these joints is best illustrated by Fig. 1. In the sizes from 2 in. up, the tool is locked on the pipe by a cone that expands four links against the inside of the pipe when a bolt is tightened. This is to hold the tool rigid on the pipe so that the groove is cut by the tools, mounted as shown in Fig. 1. The tool may be driven by hand or by a power drive and the work may be done on a bench, in a trench or anywhere, it is stated. Figure 2 shows the rear end of tools Nos. 20 and 50 for 2 to 3½-in. and 4 to 7-in. pipe respectively, showing the action of the four links.

For 8 to 12½-in. pipe, No. 120, and for 14 to 16-in. pipe No. 160 tools have a different type of locking device but the principle is the same. Because of the weight of these No. 120 and 160 tools, two men are required to put them in place although one man can operate them. Only one man, however, is needed to install the Nos. 20 and 50.

For pipe smaller than 2 in., that is down to ½-in., the No. 12 tool does not lock on the inside of the pipe and the tool cuts a groove conforming to the contour of the pipe. On such small sizes, however, it is stated that the error from this cause will seldom be of consequence.

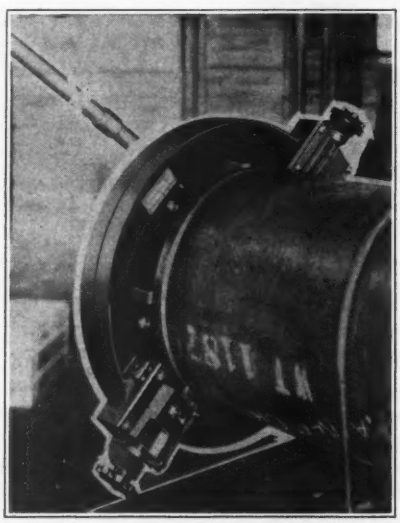


FIG. 1. BEAVER GROOVING TOOL NO. 20 AND 50 IN PLACE ON END OF PIPE, DRIVEN BY HAND

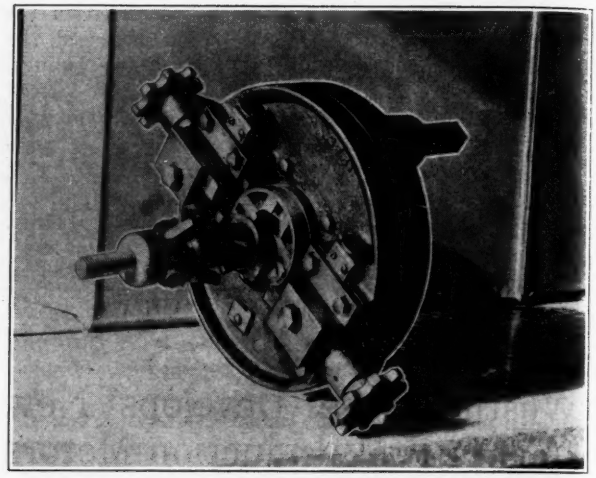


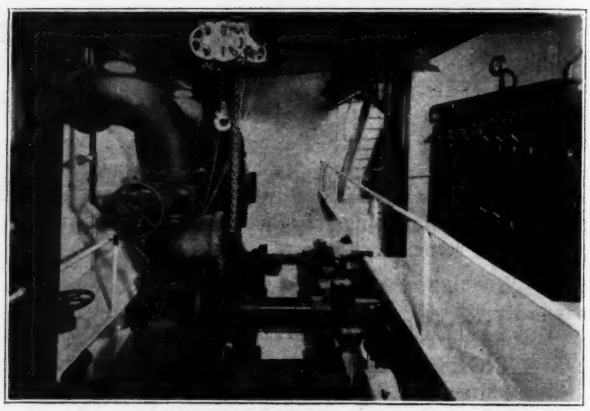
FIG. 2. REAR END OF SAME TOOL SHOWING ACTION OF CLAMPING LINKS

The No. 12 tool may also be used as a square end pipe cutter.

These new Beaver grooving tools are made by The Borden Co., Warren, Ohio.

City of Los Angeles' New Storm Drain Disposal Plant

NEW STORM DRAIN DISPOSAL plant recently placed in operation by the city of Los Angeles in the Venice district is one of the most complete plants of its kind on the Pacific Coast. Drainage canals, utilized prior to the installation of this plant, were all filled in and made into beautiful broad level streets. The pump installation is a battery of five 10,000-g.p.m. centrifugal pumps manufactured by Fairbanks, Morse & Co. These are individually motor driven through American High-Speed Chain Drives, enclosed in oil-tight casings. The motors are automatically float controlled so that any one or number of pumps may work singly or in unison as required. Thus the total capacity of the installation attains 50,000 g.p.m.



VIEW OF PART OF PUMPS IN STORM DRAIN DISPOSAL PLANT

THE WORLD'S first sea-going metal ship was made of wrought iron at London in 1820.

Morrell St. Station Renamed for Late Frank D. Mistersky

IN RECOGNITION of long and honorable service of the late Frank R. Mistersky to the Public Lighting Commission of Detroit, Mich., and to the city of Detroit and of "his untiring and loyal devotion to duty and his distinguished attainments in the field of municipal lighting," the commission has officially designated its principal power station at the foot of Morrell St. as the Mistersky Power Station. Complete data on this plant were given in Power Plant Engineering, Nov. 15, 1927 issue and April 1, 1928 issue.

Frank R. Mistersky, general superintendent of the Public Lighting Commission, City of Detroit, Mich., died on January 6, after 30 yr. of service to the city, 20 of which were spent as general superintendent. He was born in West Prussia, Germany, in 1863, came to this country with his parents, studied electrical work in Detroit and was associated with several electrical firms before becoming a city employe.

News Notes

READING CHAIN & BLOCK CORP., Reading, Pa., has added W. C. Minier and F. C. Lorenz to its Cleveland sales and engineering staff, under George R. Harrison, district manager. Mr. Minier was formerly connected with the Shepherd Crane & Hoist Co. Mr. Lorenz was for years with The Cleveland Electric Tramrail Co.

EFFECTIVE February 1, M. C. Steffen becomes Manager of the Cincinnati Office of Cutler-Hammer, Inc., with headquarters at Milwaukee, Wisc. Mr. Steffen takes the place of R. I. Maujer, who has resigned. Mr. Steffen comes to Cincinnati from the St. Louis Office of C-H where he has been stationed the last five years.

FRED W. DUMLER has been elected as vice-president of the Walworth Co., Boston, Mass., and will be in charge of sales to oil and power industries.

FOXBORO CO., Foxboro, Mass., announces the removal of its Los Angeles office to 2307 East Eighth St., Los Angeles, Calif. Dudley M. Hill will be in charge, assisted by an entirely new staff of engineers.

THE JAMES LEFFEL & CO., Springfield, Ohio, announces the removal of its Minneapolis, Minn. office to Room 444, 20 North Wacker Drive, Chicago, Ill., effective March 1, 1930.

JOHN HICKEY has again joined the Engineering staff of the National Pipe Bending Co., New Haven, Conn. Mr. Hickey assumed his new duties on January 1 and will have direct charge of engineering in connection with research and new product development.

FOSTER WHEELER CORP., New York, announces that, effective Feb. 1, the address of its Los Angeles district office is 342-347 Petroleum Securities Building, 714 West Tenth St., Los Angeles, Calif.

ANNOUNCEMENT is made of the formation of a company known as the American Colloid Corp. incorporated under the laws of the State of New York for the purpose of manufacturing colloids for the colloidal treatment of boiler feedwater, with offices at 15 East 26th St., New York City. The factory is located at Boonton, N. J. Following are officers of the corporation: Ernest F. Drew, president; E. J. Whitlock, vice-president and sales manager; G. C. Reinhard, chief chemist; Willis E. Hainley, plant manager.

A. M. BYERS CO., Pittsburgh, Pa., has announced the appointment of the following additions to the Byers sales organization: D. S. Sampson assigned to the New York office, under Division Manager G. W. Hamill, to cover New Jersey territory; R. C. Hamlett assigned to New Orleans, under jurisdiction of Division Manager A. D. Sheere of Atlanta; Irwin P. Young, with headquarters at Chicago, under Division Manager M. G. Henderson; T. D. Graham, assigned to St. Louis territory under Chicago Division Manager M. G. Henderson.

WORD HAS BEEN received of the death of Charles A. Tripp, aged 59, former chief engineer of the Bemis Bros. Bag Co., Indianapolis, Ind., at his home in Wilmington, Del. Mr. Tripp was a graduate of the Massachusetts Institute of Technology. In 1904, with P. E. McMeans, at that time chief engineer of the Nordyke-Marmon Co., he formed the concern of McMeans & Tripp, industrial engineers. In 1918, he moved to Wilmington to become treasurer and chief engineer of the United States Flashless Powder Co. He was a member of the American Institute of Electrical Engineers.

ELECTRIC MACHINERY MFG. CO., Minneapolis, Minn., announces that the new location of its Detroit office is 10-230 General Motors Building, Detroit, Mich.

AT THE ANNUAL MEETING of the shareholders of The Wellman-Seaver-Morgan Co., Cleveland, Ohio, an amendment to the Articles of Incorporation was adopted, changing the name of the company to The Wellman Engineering Co. The new name is in keeping with the modern trend for brevity and is considered more descriptive of their type of business, which is the designing and building of apparatus for handling and transporting raw materials from the mine to the finished products. There was no change in the Board of Directors, the following having been re-elected: John A. Penton, G. W. Burrell, S. R. Willock, A. E. Gibson, Francis Seiberling, H. J. Crawford, Atlee Pomerene, John T. Webster, James Foster-Smith.

CHICAGO PNEUMATIC TOOL CO., 6 East 44th St., New York, announces the opening of a branch office at 327 Philcade Bldg., Tulsa, Okla. George J. Lynch has been appointed district manager in charge of this office. The company recently opened an office and service station at 1 West 16th St., Oklahoma City, Okla.

OTTO A. BANNER, formerly chief engineer of the Diesel Division of The Falk Corp., has been retained by Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, Mo., to act exclusively for it as consultant.

FRED M. KIMBALL, advisory manager of the motor division of the industrial department of the General Electric Company, died February 5, in Lynn, Massachusetts. Mr. Kimball had seen many years of service with General Electric and was well known throughout the motor industry.

He was born in Barton, Vermont, July 7, 1861, and received his education in Massachusetts, including a course in electrical engineering at Massachusetts Institute of Technology. He was early associated with the Merchants Electric Light Co. of Boston, the American Electric Illuminating Co. and the Electrical Development & Manufacturing Co. In 1886 he established a business partnership specializing in the manufacture and sale of isolated lighting plants, motors and electrical specialties. In 1891, he entered the employ of the General Electric Co., New England district, and in 1898 was made manager of the small motor department at its formation.

He was an associate member of the A.I.E.E., a member of the N.E.L.A., an Edison pioneer and an honorary member of the Providence Engineering Society.

LOUIS J. SCHRENK, superintendent of the former Morrell St. station, now Mistersky Power Station, of the Public Lighting Commission, Detroit, Mich., has been promoted to general superintendent of the commission, to fill the vacancy caused by the death of Frank R. Mistersky, noted elsewhere in these columns. Mr. Schrenk has served Detroit in the Public Lighting service for 20 yr. He was born in Missouri and secured his B.S. in mechanical engineering at the University of Missouri. He is a member of Detroit Engineering Society, American Society of Mechanical Engineers and National Association of Power Engineers.

BY MARCH 20, 1930, the American Society of Heating and Ventilating Engineers wil be housed in its new headquarters on the 31st floor of The New York Life Insurance Building, 51 Madison Ave., New York, where more commodious quarters have been selected by the council in order adequately to care for the increasing society activities.

THE BRISTOL CO., Waterbury, Conn., has recently opened a new sales and service office in Los Angeles, Calif. S. W. Case has been appointed district manager, and W. H. Rogers, sales and service engineer.

EFFECTIVE FEBRUARY 1, Frank J. Burd becomes manager of the Philadelphia office for Cutler-Hammer, Inc., Milwaukee, Wisc. He replaces T. E. Beddoe, who has resigned. Mr. Burd is a member of the American Institute of Electric Engineers, of the Association of Iron and Steel Electrical Engineers, Chicago Engineering Club and the Electrical Maintenance Engineers of Chicago. He was formerly at Chicago in charge of the steel mill division for the past nine and one-half years.

FLEXIBLE STEEL LACING Co., 4607 Lexington St., Chicago, Ill., announces that it can now supply sectional steel rocker hinge pins for No. 15, and a new type corrugated wire hingle pin for Nos. 00 and 1 Alligator Steel Belt Lacing. It will supply as before rawhide pins with all sizes up to and including No. 45 without any additional cost, if and when ordered. Samples of the new pins will be furnished if desired and upon request.

BOARD OF PUBLIC UTILITIES, City Hall, Kansas City, Kansas, has plans under way for extensions and improvements in municipal light and power plant, including installation of a 10,000-kw. turbine-generator unit, water-tube boilers and auxiliary equipment, reported to cost close to $1,000,000. The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

BOARD OF TRUSTEES, Lafayette College, Easton, Pa., has plans under way for a steam power plant at institution for power and heating service, reported to cost about $100,000. L. T. Klauder, Bankers Trust Bldg., Philadelphia, is architect and engineer.

GRAFTON COUNTY Electric Light & Power Co., 89 Broad St., Boston, Mass., has plans in progress for a hydroelectric generating plant at Indoes, Vt., reported to cost over $400,000 with transmission system.

ELEVATOR CONTRACT amounting to $2,900,000, the largest in the history of the building industry, was recently awarded by Starrett Brothers, Inc., 101 Park Ave., New York, to the Otis Elevator Co. The contract calls for 66 cars, covering the elevator requirements of the new 85-story Empire State building being erected for former Governor Alfred E. Smith and his associates on the site of the old Waldorf-Astoria Hotel.

According to A. J. Eken, vice-president of Starrett Brothers, so many new problems were presented in designing the elevator equipment adequate to meeting the needs of the new 1050-ft. structure that it became necessary to develop a new type of car and machinery. The new cars will be able to make a new record in elevator speeds of 1200 ft. a minute, although the city's present building code will hold their speed to 800 ft. a minute; they are self leveling and will run on an automatic dispatching system. The automatic feature will make it impossible for a car to run past a signaling passenger without flashing a warning to the chief starter on the ground floor. Many unusual devices to insure safety under all conditions have been embodied in the design.

CITY BOARD of Public Works, Hannibal, Mo., has just installed Wickes 660-hp. boilers fired by McClave-Brooks stokers and equipped with Copes feedwater regulators, Buffalo Forge Co. forced draft fans, Foster superheaters and Worthington boiler feed pumps. Boilers are designed for steam pressure of 250 lb., 100 deg. superheat. A. M. Nipper is superintendent and J. J. Wisner is chief engineer.

PROMOTION OF ROY PAGE to be general manager of the Nebraska Power Co. and K. R. MacKinnon and Fay E. Smith to be assistant general managers was announced recently by President J. E. Davidson, after approval of the board of directors. R. C. Geppert was promoted to assistant general superintendent. Mr. Page came to the power company in 1917 as assistant to the vice-president. In 1918, he was made general superintendent and in 1922, assistant general manager. He is a graduate of the University of California. He is president of the Nebraska section of the National Electric Light Association, director of the Industrial Development Corp. and member of other technical and commercial organizations. Mr. MacKinnon will be in charge of production, rural and farm electrical development, transportation, stores and purchase and accident prevention. Mr. Smith will be in charge of engineering construction and property records, transmission and distribution, substation maintenance and operation and service departments.

H. BOYD BRYDON, chief mechanical engineer, Byllesby Engineering and Management Corp., and for 21 yr. a member of the Byllesby organization, has resigned, effective March 17. Mr. Brydon was born in London, England and educated at Finsbury Technical School, London. In 1900, he joined the firm of Sargent and Lundy as assistant engineer and in 1909, joined the engineering department of H. M. Byllesby & Co. During his affiliation with the Byllesby organization, he has worked on such projects as the Galena power plant of the Northern States Power Co., built in 1909, the first steam plant constructed by the engineering organization; Waterside Station, Louisville Gas & Electric Co.; Riverside and High Bridge stations of Northern States Power Co.; Colfax and James H. Reed stations, Duquesne Light Co. Mr. Brydon is a member of the American Society of Mechanical Engineers and the Western Society of Engineers. Several years ago, he translated from the French, Rateau's book on Experimental Researches in the Flow of Steam Through Nozzles and Orifices.

AS PART of its $78,000 program for increasing power production capacity of the Cedar Falls, Iowa, municipal electric power plant, the council has awarded the Westinghouse Electric & Mfg. Co. contracts for two underfeed stokers at a cost of $11,238 and the Murray Iron Works, Burlington, two 412-hp. boilers at a cost of $17,000, as well as miscellaneous contracts incidental to installation of the unit.

PROPOSED RATE reductions of the Central Illinois Public Service Co., schedules for which have been filed with the state commerce commission, will affect 440 downstate cities and rural territories in Illinois and are scheduled to be effective April 1. A one cent reduction in residential lighting rate in the first step is proposed for all the communities, except Quncy, Ill., in which the one cent reduction applies to the third step in the tariff. In the other cities, second and third steps are unchanged.

AT THE STOCKHOLDERS' meeting of the Sivyer Steel Casting Co., Milwaukee, Wisc., recently consolidated with The Nugent Steel Castings Co., Chicago, Ill., the following officers were elected: C. R. Messinger, chairman of the board; L. S. Peregoy, president; M. A. Fladoes, vice-president in charge of sales; George L. Pollock, secretary; C. A. MacDonald, treasurer. The directors are: C. R. Messinger, W. C. Frye, Walter Kasten, Donald Fraser, C. F. Messinger, E. L. Wood, L. S. Peregoy, C. A. MacDonald, M. A. Fladoes, C. E. Stone.

THE UNITED STATES Civil Service Commission announces open competitive examination for Architectural Engineer, applications for which must be on file with the Civil Service Commission at Washington, D. C., not later than April 9.

The examination is to fill a vacancy in the Bureau of Animal Industry, Department of Agriculture, Washington, D. C., and vacancies occurring in positions requiring similar qualifications, for duty in Washington, D. C., or in the field. The entrance salaries range from $3,800 to $4,400 a year. Higher-salaried positions are filled through promotion.

The Commission also announces examination for Instrument Maker, applications for which must be on file with the Commission at Washington, D. C., not later than April 9. The examination is to fill vacancies in the Bureau of Standards and the Geological Survey, Washington, D. C., and in positions requiring similar qualifications. Entrance salary is $1,620 a year. Higher-salaried positions are filled through promotion. The duties are to design, construct, and repair scientific and technical instruments and apparatus of high precision.

Competitors will not be required to report for examination at any place, but will be rated on their education, training and experience.

Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or the Secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

Catalog Notes

LINK-BELT Skip Hoist is illustrated in a handsome book, No. 946 of the Link-Belt Co., which shows types, details of construction and of operation, types of loaders, dimensions and capacities, also examples of installations. Copies may be had from Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.

NICKEL ALLOY Steel Products are listed in a buyers' guide arranged alphabetically according to products and with manufacturers of each product listed alphabetically under it. The list covers 12 pages and includes some 1300 manufacturers. It is issued by The International Nickel Co., Inc., 67 Wall St., New York City.

STREAMS of Gold is the arresting title of a pamphlet issued by Edwin Burhorn Co., Fort W. 5th St., Bayonne, N. J., describing installation of a cooling tower for a refrigerating plant of Fischer Baking Co., Newark, N. J.

AMERICAN REFRACTORIES INSTITUTE has adopted a Code of Ethics, which is published in pamphlet form, in an effort to eliminate unfair competition and trade practices from the refractories industry and to reduce economic waste. The Institute is publishing also specifications tables and diagrams covering the classification of Modified Rectangular or Difficult Fire Clay, Silica and High Alumina Shapes. Copies can be had from G. M. Basford Co., 17 E. 42nd St., New York. N. Y.

MODERNIZING Heating Systems is the subject of a booklet showing new types of air traps and the methods by which they can be converted into the latest type, by means of attachments, without changing the trap body. The booklet is issued by Warren Webster & Co., Camden, N. J.

TO MEET modern requirements for U-gages, the new Ellison cover type U-gage has recently been placed on the market. It is rigidly enclosed in a compact dust-proof case and has a sliding scale for zero adjustment. For low pressures it employs colored oil as the indicating liquid; this oil, it is stated, evaporates only slightly and does not coat the glass. Use of red oil in a large bore tube over a white scale is intended to give good visibility. It is supplied in several types and sizes: Types A, B and C for ranges of 4 to 20 in., measuring in inches of water, using oil; Types D, E and F, from 5 to 24 in., indicating in inches of mercury, using mercury. It is described by its maker, Ellison Draft Gage Co., 214 West Kinzie St., Chicago, Ill., in Bulletin 13, recently issued. It is designed to have many applications for reading pressures, minus, plus or differential, of air and gases and for both stationary and portable use.

TAYLOR STOKERS are fully described in a new catalog issued by the American Engineering Co., Philadelphia, Pa. It gives a complete description with illustrations in colors of all types of these stokers, then drives, construction, operation and operating results. It is attractive as a fine piece of catalog making as well as from the standpoint of technical information.

CALDWELL Elevator Drive for vertical bucket elevators is described and illustrated in Book No. 1086, of 24 pages, issued by H. W. Caldwell & Son Co., Chicago, Ill. Dimensions, speeds, power delivered and charts for determining sprocket and reducing gear ratios are given.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., announces the release of Circular 1825 on Type H Bus-Bar Supports for indoor usage. This 28-page booklet describes the line of standard-duty and heavy-duty bus-bar supports giving details of construction, distinctive features, and fittings for these supports. A complete list of the different kinds and sizes of supports rated at 7500, 15,000 and 25,000 v. for supporting cables of various sizes is included. Dimensioned drawings of each support are also shown. Copies of this booklet may be procured from any Westinghouse District Office or from the Advertising Department in East Pittsburgh, Pa.

SHALLCROSS FURNACE DRAFT CONTROL is described in a recent 12-page illustrated bulletin by Shallcross Control Systems Co., Milwaukee, Wisc. This discusses the general subject of automatic draft control, describes the Shallcross draft switch, the motor drive for dampers, the control station with pilot lights and shows how the control system is applied to control of boiler furnaces.

SMALL WATER TURBINES of the reaction, inward flow or vortex type, are described in a publication issued by the De Laval Steam Turbine Co. of Trenton, New Jersey. The wheel is mounted upon a horizontal shaft completely enclosed in a horizontally split cast-iron housing and can be located in a room well above the tail race, at the same time utilizing the full head. Details of construction, sizes and data for estimating capacity available in a stream are given.

COMBINED DEAERATOR and hot-water generator for supplying hot, deaerated water to heating and hot-water service systems is described in Bulletin 686, distributed by the Cochrane Corp., Philadelphia, Pa. The apparatus is designed to heat the water to a temperature determined by thermostatic control and also to drive off oxygen and other dissolved gases so that the water will not corrode iron, steel or brass piping, heating coils, and will not cause trouble from leakage or choking up of piping or from "red water." The water is not heated by direct contact with the steam but by heating coils, so that the steam used for heating is kept apart from the water being heated to prevent any taste or smell being imparted to the water. It also conserves the condensate for return to the boiler free of contamination by scale-forming matter. The apparatus is self-contained, compact and has been specially designed for installation in crowded basement boiler and engine rooms where there is only limited head room. Diagram showing hot-water piping systems adapted for various types of buildings are given in the bulletin.

NEW SERVICE to aid business executives in making effective use of the thousands of informal mimeographed reports, tabulations and statistical summaries issued by government bureaus at Washington, is announced by the Special Libraries Association, 11 Nisbet St., Providence, R. I., which has been organized co-operatively by a representative group of business librarians. The association has just issued A Descriptive List for use in Acquiring and Discarding United States Government Periodical Mimeographed Statements which indexes and describes government releases ranging in subject from the ravages of the Mediterranean fruit fly to the weekly reports of brokers' loans. Each item is marked "keep" or "discard," to advise whether the material in question will be later duplicated in printed form. The publication price is $1.75.

OXWELDED CONSTRUCTION for Modern Piping Services is the title of a booklet that presents facts pertinent to and advantages of the oxy-acetylene process for the fabrication of steel and wrought-iron piping systems for all purposes. It has 76 pages, well illustrated, covering general construction and special applications. Copies may be had from Linde Air Products Co., 30 E. 42nd St., New York, N. Y.

WESTINGHOUSE ELECTRIC & MFG. CO. has published and is now distributing a catalog providing within a single convenient volume, complete information covering line material for railways and mines. The catalog is illustrated and contains brief descriptions of nearly all articles listed. All articles are indexed both alphabetically and by style number, making them easily located.

RECENTLY a 24-page illustrated bulletin on the Tallmadge System of Zone Heating has been prepared for architects, engineers, building owners and managers interested either in heating plans for new buildings or in improving ineffective or wasteful existing heating systems. This bulletin discusses the many problems involved in the correct design of a heating system, shows how various typical service conditions may be successfully provided for and explains in detail the special features and advantages of the Tallmadge Zone System, together with its method of remote control. Diagrams show how proper distribution of heat may be obtained in buildings of various types. Examples of the savings effected by the Tallmadge Zone System are given. Copies of the bulletin may be obtained by addressing Webster Tallmadge & Co., 50 Church St., New York City.

BULLETIN 130, on the Ljungstrom Air Preheater, contains several charts illustrating the benefits obtained from air preheating, gives examples of the savings that can be accomplished under typical operating conditions, explains the functions and advantages of air preheaters, compares various types of equipment for this purpose, and discusses in detail the features of construction and special advantages of the Ljungstrom Air Preheater. The bulletin is profusely illustrated with sectional views, diagrams and photographs of installations and endeavors to present thoroughly all phases of the subject of air preheating. Readers may obtain copies from The Air Preheaters Corporation, Wellsville, New York.

FOR MANY years, the Stockham Pipe & Fittings Co., Birmingham, Ala., has published a vest-pocket-size catalog. With numerous additions to the Stockham line, which now comprises over 7500 different fitting patterns, a new catalog has just been issued which brings all of the Stockham items under one cover. The new publication, catalog H, contains 359 pages. It is still in the handy vest-pocket size and besides performing the regular function of a catalog, it contains dimension data to help in estimating the fittings for any job.

WESTINGHOUSE OUTDOOR SWITCHHOUSES is the title of an eight-page booklet C-1861 recently released by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Application, distinctive features, construction and advantages of outdoor switchhouses with manual, motor or solenoid-operated oil circuit breakers are given. General and equipment specifications are listed in full for each of the three different types, with a description of the automatic reclosing equipment, which is available for all electrically-operated breaker equipments and is recommended for all feeder circuits. Outline dimensions and drawings of the different types of switchhouses complete the circular.

ELECTRIC RATES AND THEIR STATUS in 1929, Publication No. 05, of the Rate Research Committee, deals with the status of electric rates and rate forms in 1929, reviewing historically the changes in forms over a period of years. Striking evidence of the increasing use of the promotional rate forms for residence service is disclosed, 278 out of 392 large cities now having such rates available as against 124 in 1922. Comment is given to the three cost components in residence service,—demand, customer and energy costs, illustrating the relative minor part of the energy portion. The advantages of various rate forms are considered, but the experience of companies using promotional rate forms indicates that the particular form used for domestic service is not vital. The report recommends that the top rates should not under normal conditions be reduced. It is predicted that in the near future rates of straight-line character will be obsolete.

Power Plant Construction News

Ala., Jackson—The Carlisle Veneer Co., Jackson, Fred A. Carlisle, president, is said to be planning the installation of electric power equipment in proposed new veneer mill, entire project reported to cost close to $90,000.

Ark., Jonesboro—The Home Ice Co., recently acquired by new interests, is considering extensions and improvements in local ice-manufacturing plant, including installation of additional equipment. A. A. Brown, heads the company.

Calif., Orange—The Consolidated Orange Growers Association, Orange, plans construction of a precooling plant adjoining present packing house, to cost close to $80,000, with machinery.

Colo., Canyon City—The Southern Colorado Power Co., Pueblo, has approved plans for extensions and improvements in local power plant, and will proceed with work at early date. W. N. Clark is general manager.

Ga., Atlanta—The Georgia Power Co., is said to have plans under way for extensions and improvements in its Piedmont power substation, with installation of additional equipment to double present capacity.

Idaho, Idaho Falls—The City Council is considering the installation of new generating unit in hydroelectric power plant No. 2, on the Snake River, reported to cost close to $90,000, with auxiliary equipment.

Ill., Princeton—The City Council is having plans completed for an iron removal plant for municipal waterworks, estimates to cost about $25,000. Shields, Jordan & Roe, 205 West Wacker Drive, Chicago, Ill., are consulting engineers.

Ind., Anderson—The Ames Shovel & Tool Co., Plans installation of electric power equipment in proposed rebuilding of portion of local plant, recently destroyed by fire with loss reported in excess of $150,000.

Ind., Indianapolis—The Big Four Railroad (Cleveland, Cincinnati, Chicago & St. Louis Railroad), Big Four Building, Cincinnati, Ohio, plans installation of electric power equipment in proposed rebuilding of car shops at Beach Grove, a suburb of Indianapolis, recently destroyed by fire with loss reported in excess of $500,000.

Iowa, Des Moines—The Des Moines Electric Light Co., Equitable Building, Des Moines, is said to have plans under way for a steam-operated electric power plant to cost over $2,000,000. Company engineering department, address noted, is in charge.

Iowa, Des Moines—The Peoples Ice Co., 2801 Sixth Avenue, has filed plans for a one-story ice-manufacturing plant, 100 x 130 ft., reported to cost more than $60,000, with equipment. Proudfoot, Rawson, Souers & Thomas, Hubbell Building, Des Moines, are architects.

Kan., Fort Scott—The City Council has plans nearing completion for a filteration plant for the municipal waterworks, reported to cost more than $75,000. Black & Veatch, Mutual Building, Kansas City, Mo., are engineers.

Md., Baltimore—The Sellmayer Packing Co., 531 South Conklin Street, is completing plans and will soon take bids for a three-story cold storage and refrigerating plant, estimated to cost more than $150,000, with equipment.

Mass., Boston—The Board of Trustees, City Hospital, has filed plans for the construction of a power plant at institution at Mattapan, to cost $250,000, with equipment. James H. Ritchie & Associates, 100 Arlington Street, Boston, are architects.

Mich., Holland—The City Council has plans under way for extensions and improvements in municipal electric light and power plant, reported to cost more that $100,000, including equipment. R. P. Champion, City Hall, is city engineer; Giffels, Hamilton & Weeber, Grand Rapids National Bank Building, Grand Rapids, are consulting engineers.

Miss., Pascagoula—The Pascagoula Cold Storage & Ice Co., recently organized, has plans nearing completion for a one-story ice-manufacturing and cold storage plant, reported to cost about $50,000, with equipment. E. K. Strahan, Inc., Pere Marquette Building, New Orleans, La., is consulting engineer. W. W. Lindinger is president.

Mo., Campbell—The City Council is said to be arranging an early call for bids for a municipal electric light and power plant to cost about $80,000. Russell & Axon, 6200 Easton Avenue, St. Louis, are engineers.

Mont., Great Falls—The Great Northern Railway Co., Railroad Building, St. Paul, Minn., is reported planning construction of a steam-operated power plant in the vicinity of Great Falls, estimated to cost over $200,000; pulverized coal will be used as fuel. R. W. Davis is chief engineer.

Neb., Falls City—The City Council has plans for extensions and improvements in municipal electric light and power plant to cost about $50,000. J. M. Mullen is city engineer.

Neb., Omaha—The Chicago, Burlington & Quincy Railroad Co., 547 West Jackson Boulevard, Chicago, Ill., has plans maturing for a power plant on Ninth Street, Omaha, to cost about $70,000, with equipment. Company engineering department is in charge.

N. J., Bloomfield—The Bakelite Corporation, 230 Grove Street, plans installation of electric power equipment in new three-story addition to insulating material plant addition, entire project reported to cost about $100,000. Robert Bolton, 45 Branford Place, Newark, N. J., is architect. Company headquarters are at 247 Park Avenue, New York.

N. J., Camden—The RCA Victor Corporation plans installation of electric power equipment in connection with proposed additions and improvements in talking machine and radio equipment plant on Delaware Avenue, entire project reported to cost more than $7,000,000.

N. Y., Binghampton—Our Lady of Lourdes Memorial, 160 Riverside Drive, has revised plans under way for a power plant in connection with a new hospital and other institutional buildings, entire project to cost about $450,000. Murphy & Lehman, 208 Livingston Street, Brooklyn, N. Y., is architect.

N. Y., Niagara Falls—The Kimberly-Clark Co., Neenah, Wis., plans installation of electric power equipment in proposed five-story addition to paper mill at Niagara Falls, entire project to cost about $200,000.

N. C., Charlotte—The Standard Ice & Fuel Co., 700 West Ninth Street, is considering extensions and improvements in ice-manufacturing plant, including installation of a Diesel engine unit and auxiliaries.

Ohio, Cleveland—The Kroehler Mfg. Co., 1644 Doan Avenue, plans installation of electric power equipment in proposed addition to furniture factory to cost more than $150,000. J. O. Taylor, 243 South Dearborn Street, Chicago, Ill., is architect and engineer.

Okla., Clinton—The Common Council is said to be planning the installation of pumping machinery and auxiliary equipment in connection with extensions and improvements in municipal waterworks, for which a bond issue of $600,000, recently was approved.

Pa., Concord—The Board of Commissioners of Delaware County, Court House, Media, Pa., has plans under way for a steam power plant at Concord for central heating service. George S. Idell, 1510 Chestnut Street, Philadelphia, Pa., is engineer.

Pa., Philadelphia—The Philip Carey Mfg. Co., Lockland, Cincinnati, Ohio, plans construction of a boiler plant in connection with proposed branch factory on seven-acre tract of land at Philadelphia, for manufacture of roofing material and asbestos products, entire project reported to cost more than $350,000.

Pa., Sharon—The Pennsylvania Power Co., Sharon, is completing plans for the construction of an out door power substation on local site, to cost about $140,000, with equipment. Stevens & Wood, Inc., 20 Pine Street, New York, is engineer.

Que., Montreal—The Nichols Co., 25 Broad Street, New York, plans construction of a power plant at proposed new copper refining plant at Montreal East, a suburb of Montreal, entire project to cost about $2,000,000. Project will be carried out by a subsidiary, now being organized, to be known as the Canadian Copper Refiners, Ltd.

Tenn., Jackson—The City Council is considering extensions and improvements in municipal electric light and power plant, reported to cost more than $500,000, with equipment. Preliminary surveys are being made by the Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo.

Texas, Houston—The O. B. Andrews Co., plans installation of electric power equipment, in connection with proposed extensions in paper box manufacturing plant, entire project to cost about $80,000. Headquarters are at Chattanooga, Tenn.